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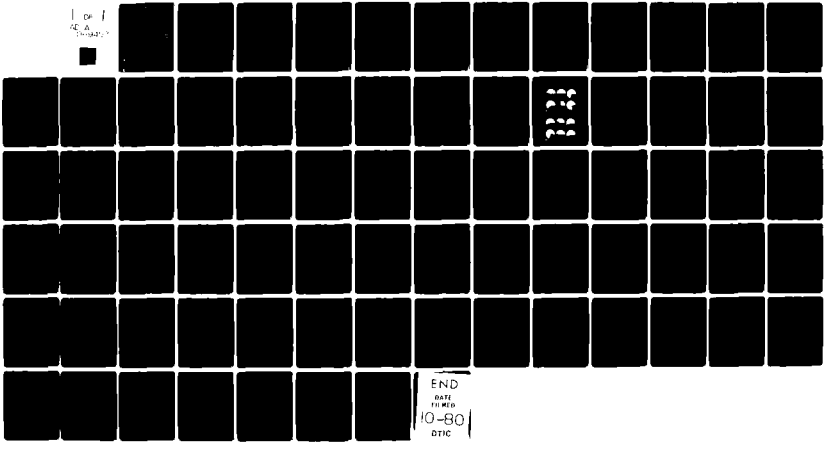

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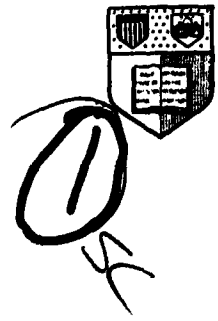

Contributions to Economic Development of Science and Technology Institutions in Nigeria and Opportunities for Bilateral Cooperation

G. E. Schweitzer and H. T. Bergh

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September 1979

Final Report to U.S. Department of State

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CONTRIBUTIONS TO ECONOMIC DEVELOPMENT OF SCIENCE AND TECHNOLOGY INSTITUTIONS IN NIGERIA AND OPPORTUNITIES FOR BILATERAL COOPERATION

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September 1979

This study was funded by the Department of State under Contract No. 1751-300350. However, views and conclusions contained in this study should not be interpreted as representing the official opinion or policy of the United States Government.

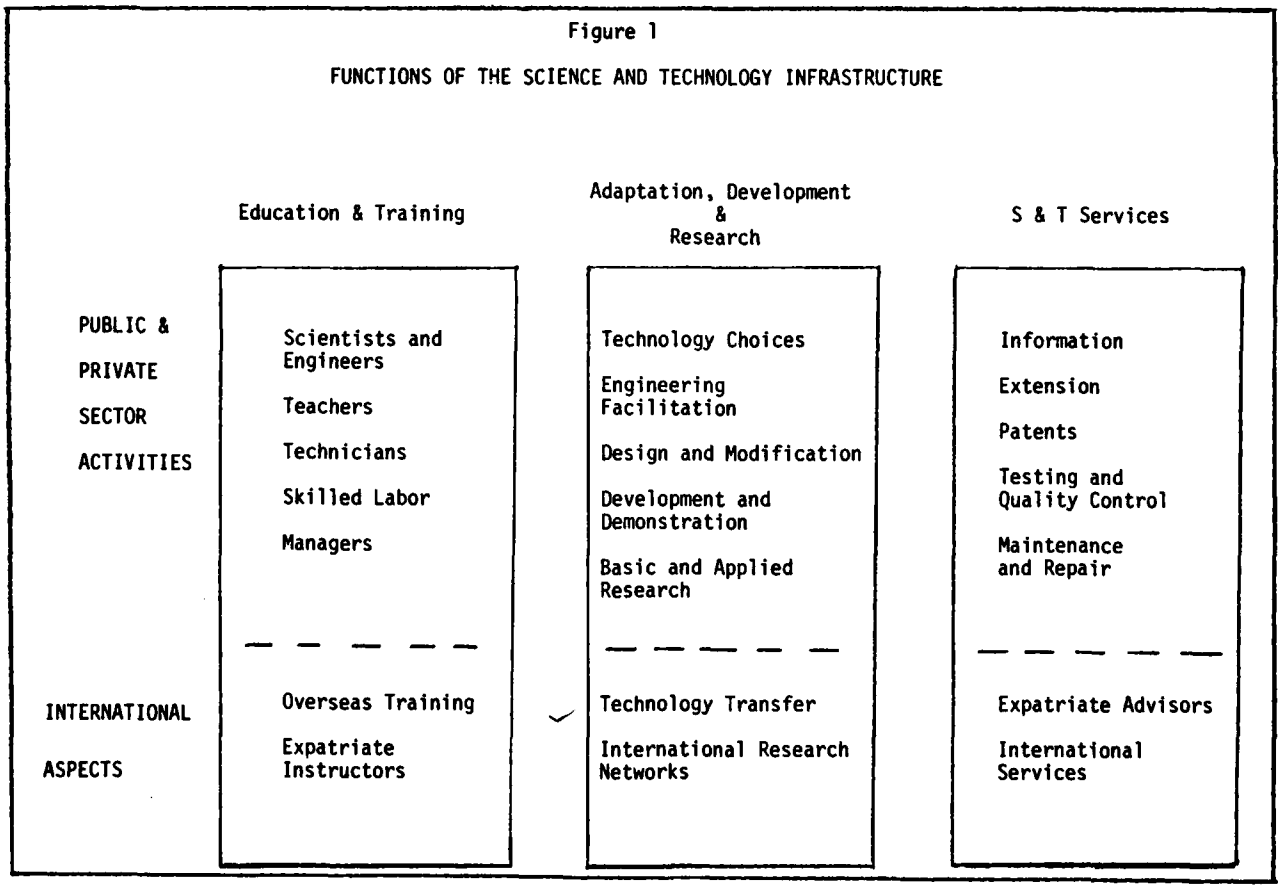
PREFACE

This report analyzes (a) the characteristics and capabilities of the principal institutions that comprise the science and technology infrastructure in Nigeria, (b) the potential contribution of these institutions to industrial development, and (c) opportunities for bilateral cooperation between these institutions and institutions in the United States. Two companion reports analyze similar activities in Malaysia and Colombia. A fourth report presents a cross-country comparison of some of the principal findings in the three country reports. A final report describes the methodology used in carrying out the country studies.

Figure 1 sets forth the principal activities carried out by the institutions that comprise the science and technology infrastructure. Special attention has been given to the interactions among these institutions and between their activities and the activities of production organizations.

Figure 1

FUNCTIONS OF THE SCIENCE AND TECHNOLOGY INFRASTRUCTURE



The emphasis is on science and technology activities which relate directly and indirectly to manufacturing; to some aspects of agriculture; to the physical infrastructure needed to support industrial development, including transportation, communication, power, and water systems; to development of the natural resource base; and to the education and training of science and technology professionals and skilled labor. Science and technology directed to medicine, public health, reproductive biology, and nutrition are not considered.

The findings in the report are based largely on observations by a team of senior Cornell faculty members who visited Nigeria in March 1979. These observations were supplemented by documentation collected during and after the visit, principally from Nigerian sources.

Special appreciation is extended to the National Science and Technology Development Agency and to many other Nigerian organizations which assisted in the collection of much of the data presented in the report and provided insights as to the problems and opportunities in the application of science and technology in Nigeria. Also, the assistance of the U.S. Embassy in Lagos, the American Consulates in Kaduna and Ibadan, and the Department of State in facilitating the study and providing helpful suggestions is gratefully acknowledged.

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EXECUTIVE SUMMARY

Nigeria has high expectations for the payoff from investments in science and technology. There are a substantial number of highly trained, and in some cases internationally recognized, Nigerian scientists and engineers. University standards are generally high. The Government's organizational and policy approaches to science and technology are being developed, and priorities are being set within the framework of national development objectives. Most importantly, the leadership of Nigeria recognizes the potential importance of strengthened science and technology institutional capabilities in accelerating progress toward modernization while also meeting basic needs. They are aware of many of the bottlenecks in developing this potential, and they are beginning to take steps to address some of these problems. In this regard, a new generation of educated Nigerians seems prepared to try new approaches to applying science and technology.

However, Nigeria's base in science and technology is still in its infancy. Few educational institutions are adequately staffed, and the availability and use of appropriate equipment is uneven. Little research is carried out within either the public or private sector, with the exception of research in some areas of agriculture. Major technology adaptations are infrequent and seldom reflected in production activities. Limited service and maintenance personnel and facilities are unable to maintain the communications, power, and water systems hastily introduced into the country in the absence of a technological base. Finally, the degree of coupling among Government, university, and private sector activities in science and technology is spotty at best. In particular, the agriculture extension services have not been effective conveyors of technology, and the private sector has not been very interested in introducing innovations either in agriculture or industry.

Further development of Nigeria's technological capabilities is currently highly dependent on overseas training of scientists and engineers, expatriate instructors throughout the educational system, importation of foreign technologies, including installation and servicing of equipment by foreign firms, and foreign assistance programs directed to strengthening training, research, and technical services capabilities. Reducing such foreign dependence is an important Nigerian objective. Clearly, one key to greater technological self-sufficiency is more effective utilization of the well trained Nigerian scientists, engineers, and technicians currently resident in Nigeria and in the educational pipeline. Critical analysis of the Government's policies, the incentives, and the working conditions that influence the matching of talent with technical manpower needs at all levels should be at the top of the priority list in efforts to upgrade the technological base of the country.

In considering technical manpower, three steps are urgently needed: a comprehensive review of the future role of polytechnical institutes; an improvement and enlargement of secondary school science and mathematics instruction; and development of more effective mechanisms for expanding the pool of skilled manpower. Faculties, students, and employers are disgruntled with the polytechnical institutes which, originally, were intended to provide supervisors for industrial operations, but which in large measure have rapidly changed to providing academically oriented, second class university-type training. The university science and engineering faculties are under-utilized due to a shortage of qualified applicants with appropriate science and mathematics backgrounds. With regard to skilled manpower, broadly based national apprenticeship programs designed jointly by the private sector and Government might be a useful comple-

ment to the current emphasis on formal training programs which have not been very successful.

Most of Nigeria's activities in science and technology could benefit from collaborative arrangements which effectively draw on the experience of U.S. institutions that have successfully addressed similar problems, albeit in different settings, for many years. However, these U.S. institutions must be carefully selected on the basis of past performance and of commitment of high quality scientists and engineers. The Nigerian leadership in science and technology, at both the national and the institutional levels, is quite sophisticated and gives great importance to the quality of the participants in technical endeavors. Still, there is a continuing temptation on the part of both the U.S. and the Nigerian Governments to draw on those U.S. specialists and institutions which are most readily available with inadequate regard for demonstrated capabilities.

The universities and Government research institutes are the most obvious Nigerian institutions for participation in collaborative endeavors. Such collaboration should have the dual objectives of (a) upgrading the technical capabilities of these institutions, and (b) linking them more closely to one another and to agricultural and industrial production activities. U.S. scientists and engineers who are willing to spend one or two years in Nigeria could be particularly helpful in the design and orientation of research and graduate teaching programs which are currently in their embryonic stages. Periodic review of on-going research at the universities and research institutes by experienced U.S. researchers during short visits to Nigeria could help avoid blind alleys and insure both the quality and relevance of research. Finally, arrangements involving U.S. and Nigerian institutions in joint research endeavors and faculty exchanges could add a new dimension to the current approach to bilateral "linkages" which are now directed almost entirely to the training of students.

Even if adequate funds are available, there will be some difficulty in attracting high quality U.S. scientists and engineers to participate in cooperative programs. Only in a few fields such as anthropology and tropical medicine would there be technical rewards for U.S. specialists. However, if a sufficiently broad net is cast among the many well established U.S. academic institutions, which should be the primary source of participants in sustained cooperative programs, a number of competent scientists and engineers with a pioneering zeal probably could be encouraged to spend time in Nigeria. The other primary source of U.S. participants in cooperative programs will be the technical agencies of the U.S. Government. They are more likely to participate in relatively brief survey missions, although occasionally the Department of Interior, Department of Agriculture, and other agencies might be encouraged to detail personnel to Nigeria on extended assignments.

Little effort has been made by the Nigerian Government to exploit the training capabilities of multinational firms operating in Nigeria. Some firms might be willing to extend training opportunities to employees of their suppliers and of the users of their products as well as to their own employees. Also, the training components of technology transfer packages might more explicitly address training not only for operating imported equipment but also for maintaining, upgrading, and, in some cases, eventually replicating the equipment. The jet aircraft maintenance facility being planned near Lagos, which will be based almost entirely on the transfer of foreign technological skills, offers an excellent opportunity to link operational activities with a major training initiative. Consideration should be given to co-locating with this facility a major technician train-

ing school that would cater not only to aircraft maintenance personnel, but also to a broader range of technicians from throughout the country needing related skills. Similarly, the planned National Technology Development Centre might be co-located with with an engineering faculty of one of the universities to conserve on facilities and equipment and foster a range of interactions between the educational and research communities. In both areas, the U.S. Government should consider the desirability of participation of U.S. institutions in technological collaborative programs during the initial development of the facilities.

The current approach of the U.S. Government to science and technology exchanges should be reviewed. The bilateral talks have raised unfulfilled expectations. The Department of State and AID tend to promote various types of exchanges that are proposed by U.S. specialists with inadequate attention to quality, redundancy, or Nigerian priorities. Also, the exclusive focus of the proposed U.S. foreign assistance effort on agriculture inadvertently diverts attention from other sectors of critical importance to the problems of sustained growth, unemployment, and urban migration -- sectors where U.S. science and technology could probably have an impact no less significant than in agriculture.

An encouraging development to bring better coherence to U.S.-Nigerian interactions in science and technology is the recent establishment of a broadly based non-Governmental Continuing Committee of Nigerian and U.S. scientists and engineers to analyze critical problems, sort priorities, and stimulate needed programs. The U.S. Government should provide the very modest funding required to enable active U.S. participation in this committee.

COUNTRY SETTING

General Outlook

Nigerian leaders are determined to use petrodollars to modernize the economy, to improve job opportunities and services throughout the nation, and to enhance the country's leadership role in Africa. In the short run, large infusions of foreign goods and technologies have been viewed as the only feasible avenue towards progress despite inadequacies of service and maintenance capabilities. At the same time, the political and economic realities of greater economic self-reliance have been recognized.

With rising oil prices and increased worldwide demand, Nigeria should earn substantial oil revenues for the next twenty to forty years. The proposed LNG plant at Bonny should further increase earnings. The objective is to "develop Nigeria before the oil and gas run out." This unyielding deadline has inspired many crash development programs. However, foreign exchange earnings, seemingly bountiful now in comparison to the past, are limited in the long term not only by finite resources, but also by increasing debt services. (Borrowing from commercial banks was $1.7 billion in 1978). The impact of this limitation was clearly emphasized when reduced oil exports in 1977-78 resulted in budget cuts at the universities and research institutes of more than 30 percent.

In order to reduce technological dependency on the industrialized countries, Nigeria has adopted a number of measures designed to force increased reliance on local resources. Importation of a variety of products which can be manufactured locally has been banned. Local equity in multinational companies based in Nigeria is being increasingly required. Limitations on the number of expatriates that can be employed have been imposed. Requirements are gradually being introduced for local manufacture of components for products assembled in Nigeria, such as motor vehicles. Such requirements are clearly depriving Nigeria of some short term technological advantages, and enforcement of regulations is spotty. However, in the long run, this type of pressure, if coupled with concurrent development of local science and technology capabilities, should achieve the objective of greater self-reliance.

Nigerian ties with the United Kingdom remain strong, particularly among academicians who received their degrees at prestigious U.K. institutions. The United Kingdom is also the leading exporter to and foreign investor in Nigeria. However, a growing admiration of and affinity for the American way of life usually dominates discussions of opportunities abroad. Shortcomings in the educational system and in the development of the physical infrastructure are frequently attributed to the British heritage, and the U.S. model -- particularly in education -- is perceived by many Nigerians as the best solution for their needs. Whatever the merits of this attitude toward the promise of the U.S. model, a desire for closer contacts with the United States is encountered at all levels of Government and the private sector.

For many years, a large number of international development agencies have provided assistance to most Nigerian science and technology institutions. Recently, the Nigerian Government has demonstrated a readiness to finance an increasing portion of bilateral programs. However, it seems unlikely that significant cooperative programs will materialize in the near future in the absence

of substantial external financing.

Political Concerns

Overshadowing all activities in Nigeria, are the uncertainties as to the problems and dislocations that may accompany the transition from military to civilian Government. Particularly sensitive areas are educational activities and the role of foreign companies operating in Nigeria. Hopefully, policy adjustments will be gradual and will allow the future technological effort to build on the base of activities that have been undertaken in recent years. In many ways, science and technology activities are politically neutral and can be a small, but significant, stabilizing element in times of political change.

Internationally, Nigeria is the dominant power in West Africa and is in a strong position to influence the economic and political development of its neighbors. Nigeria has not been hesitant to use its influence, including leverage in the petroleum field, in support of positions on Africa-wide issues. Nigeria plays an active role in regional science and technology activities sponsored by U.N. bodies and by the OAU. Recently, Nigeria has supported the concept of a regional technology transfer center in the country.

As the nation with the largest black population, Nigeria has special significance for many black Americans. The many Nigerian students in the United States and the U.S. visitors to Nigeria contribute to an increasing desire within Nigeria to take advantage of U.S. technological achievements in raising the standard of living. Finally, as one of our principal suppliers of crude oil, and as an expanding market for sales of U.S. goods and services, Nigeria commands high priority in our international political activities.

Social and Cultural Factors

Social and cultural factors play a major role -- and often the decisive role -- in the types of development activities that succeed in the country and in the contributions that science and technology can make to these activities. For example, difficulties of agricultural extension services in conveying modern technology to the rural farmers are, in large measure, attributable to cultural inhibitions that separate the graduates of a modern educational system and proven scientific techniques from an illiterate and distrustful population that clings to tradition.

Geographically, the country is divided into three major tribal groups (Ibo, Hausa-Fulani, Yoruba) with the recent history of civil warfare not forgotten. In almost all areas of the country, the bulk of the population lives in rural areas well below the poverty line and generally out of the mainstream of the modern economy. They treasure their tribal allegiances, wary of modern schemes proposed from the outside. At the same time, many of the rural youth who should provide much of the impetus for accelerated rural development have moved into the urban areas in search of jobs in the construction and other industries.

The population grows unabated. Modern medicine continues to increase life expectancy, and, politically, family planning remains an unacceptable concept. The population growth rate is about 2.7%, with the population probably now exceeding 80 million.

Only 25 percent of the population can read and write. When the Third Development Plan (1975-1980) introduced Universal Primary Education, primary school enrollments soared. This wave of new students will totally inundate the existing secondary schools within the next three to five years. Secondary schools are already struggling under teacher shortages, particularly in science and mathematics, and budget restrictions which will most likely worsen in the future. University enrollments have steadily increased in size, but not to the extent which Government planners had desired. Available data indicates that enrollment in all levels of education has at least doubled in the 1970s. Estimated 1979-80 enrollments are given in Figure 2.

Figure 2

STUDENT ENROLLMENT

	1979-80 (est.)	% of Population
Total population	80,000,000	
Primary	14,060,000	17.5
Secondary	720,000	.9
University	53,000	.07

Source: Ministry of Education, March 1979

In recent decades, education and social status have gone hand-in-hand in Nigeria. The following often repeated phrase reflects the attitude of many Nigerians toward education and employment, "Educated Nigerians don't like to get their hands dirty but seek a more elite status within society". Lately, however, a new generation of educated Nigerians has appeared on the scene, including many who have been trained in the United States. They are not adverse to undertaking all tasks necessary to accomplish assignments. They are often searching for new approaches for effective application of science and technology, and they offer much of the hope for future development of the nation's technological capacity.

The brain drain is a serious problem, with thousands of well trained Nigerian scientists and engineers living in North America and Europe. Many are tempted to return home in view of strong family ties. However, this attraction is often offset by employment uncertainties in Nigeria and by the prospect of one year of compulsory service in the Youth Corps after completion of education abroad. Government officials profess not to be concerned about this latent resource residing overseas, and serious overseas recruitment efforts have not received high priority. However, considerable enthusiasm was encountered among officials over the announcement that several hundred Nigerian doctors were being forced to return home by the West German Government in view of employment problems in that country.

Economic and Trade Aspects

Nigeria's development needs are enormous. The whole population continues to grow rapidly, and agricultural production has stagnated. Nigeria has changed from a net exporter to an importer of several important crops. The per capita GNP is less than $400 per year and has actually declined during the past several years. Community services are rudimentary and uncertain. A few economic indicators are presented in Figure 3.

Figure 3

ECONOMIC INDICATORS
(millions of dollars)

	1976	1977	1978 est.
G D P	25,827	27,377	27,103
Population	77.7	79.7	81.7
GDP per capita	332.4	342.5	331.7
Inflation rate	22%	30%	9%
Exports	10,149	12,029	8,987
Imports	8,080	11,048	10,668

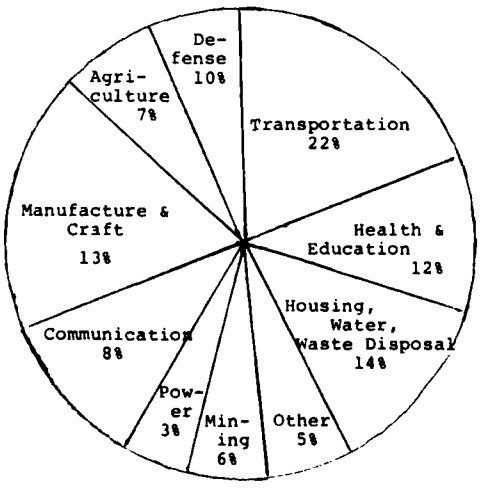
Sources: Central Bank of Nigeria
Federal Office of Statistics
March 1979

In recent years, the Nigerian Government hastily introduced a wide range of modern technologies into the economy without first introducing an adequate technology base in the service, maintenance, and spare parts industry or in a cadre of engineers and middle-level technicians capable of using the imported technologies effectively. As a result, the telephones often don't work, power failures are commonplace, and the water supply is irregular. The country now faces the dual problem of correcting these deficiencies while expanding the technical underpinning for future investments, including development of the light industries which can provide the materials, components, and supporting services for the heavier industries currently receiving so much attention.

The Third National Development Plan focused development priorities on physical infrastructure improvement. (See Figure 4.) Overly optimistic oil revenue projections and underestimation of costs prevented the extremely ambitious plan from attaining its goals. A fourth plan is being drafted which should benefit from experiences during the Third Plan.

Figure 4

BUDGET PRIORITIES



Source: Third National Development Plan, 1975-80.

As shown in Figure 5, Nigeria's trade is almost totally dependent on crude oil production. The United States purchases most of the crude oil, and as shown in Figure 6, provides a variety of manufactured and food products for the Nigerian economy.

Figure 5

NIGERIAN TRADE
(1976)

Imports		Exports	
Machinery & Transport Equip.	47.6%	Crude petroleum	93.7%
Manufactured goods	29.3	Cocoa beans	3.3
Food and live animals	8.5	Other	3.0
Chemicals	7.7		100.0%
Other	6.9		
	100.0%		

Source: Central Bank of Nigeria, Annual Report, 1978.

Figure 6

NIGERIAN-U.S. TRADE
(1977)

Imports from U.S. ($954 M)		Exports to U.S. ($6020 M)	
Machinery and Transport	$560 M	Crude oil	$5946 M
Telecommunication		Cocoa beans	$ 58 M
Aircraft		Other	$ 16 M
Construction and mining			
Cars and trucks			
Tractors			
Locomotives and streetcars			
Heating and cooling			
Mechanical haulers			
Pumps and centrifuges			
Wire and cable			
Food and live animals	$188 M		
Manufactured goods	$131 M		
Chemicals	$ 35 M		
Other	$ 40 M		

Source: International Trade Commission, November 1978.

THE SCIENCE AND TECHNOLOGY INFRASTRUCTURE

The Role of the Science and Technology Community

The Government's confidence in the potential of science and technology is reflected in a variety of organizational, policy, and program actions during recent years. However, several seemingly impossible, immediate tasks confront the science and technology community, namely:

-- Operation and maintenance of a large number of modern technological systems throughout the country (e.g., power, transportation, communications, water) which were installed largely by foreign specialists without adequate regard to indigenous capabilities to handle the systems. In addition to the usual engineering and technical problems associated with such systems, operations in Nigeria are further hampered by a frequent lack of operating manuals, difficulties in obtaining spare parts, environmental problems such as corrosion and flooding, and even compatibility difficulties among system components provided by different contractors.

-- Selection of a wide range of technologies that are best suited to Nigeria to support expansion of these systems and installation of additional systems. Competing pressures often lead to conflicting technical requirements for accelerating timetables, minimizing costs, and, at the same time, easing operation and maintenance problems.

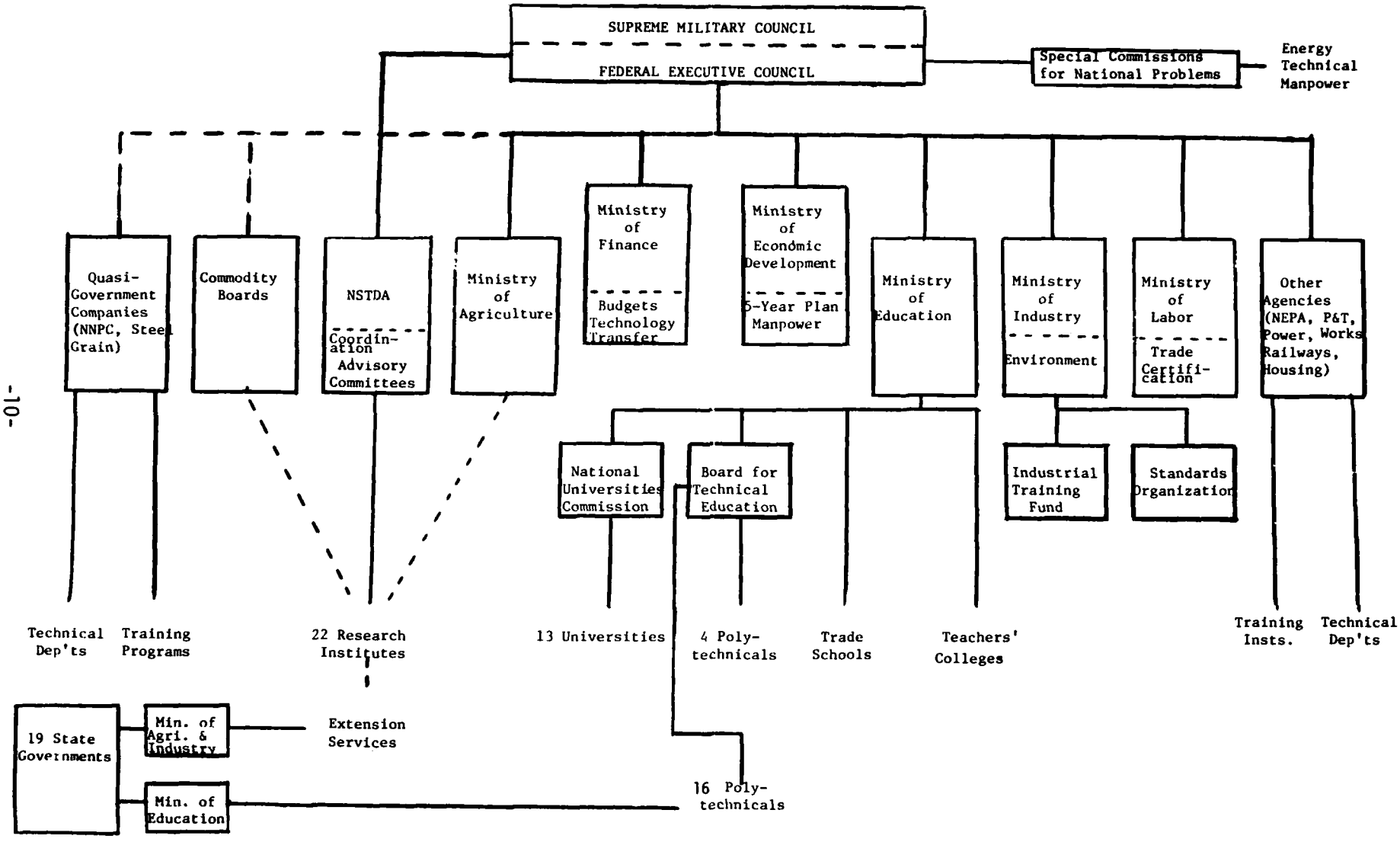
-- Management of the nation's natural resources when there is only limited knowledge as to the character, extent, and accessibility of these resources.

-- Provision of assistance to small entrepreneurs and farmers, including advice on intermediate technologies, that will enable them to improve productivity and the quality of their products. However, technology is only one ingredient of successful commercial endeavors and seldom the decisive factor.

At the same time, the science and technology community is expected to develop the institutional base in both the private and public sector that will provide the capability for handling these types of problems in the future. The necessary public institutions are to be developed despite inadequate budgets and lack of financial and other incentives to attract and retain high quality personnel. In the private sector, there is a reluctance to undertake programs with long term payoffs in view of the shifting Governmental ground rules concerning industrial and agricultural activities and uncertainties as to inflation and the future state of the economy.

Given this spread of responsibilities, it is not surprising that the current science and technology activities are critically dependent on an international component. Overseas training and expatriate instructors are essential to a viable education program. Technological adaptations and scientific techniques are more often than not replications of developments abroad. Finally, the international development agencies and international service companies provide an important technical dimension that assists in the running of many aspects of an increasingly complex economy.

Fig. 7 NIGERIAN GOVERNMENTAL ORGANIZATIONS WITH RESPONSIBILITIES FOR AGRICULTURAL AND INDUSTRIAL SCIENCE AND TECHNOLOGY



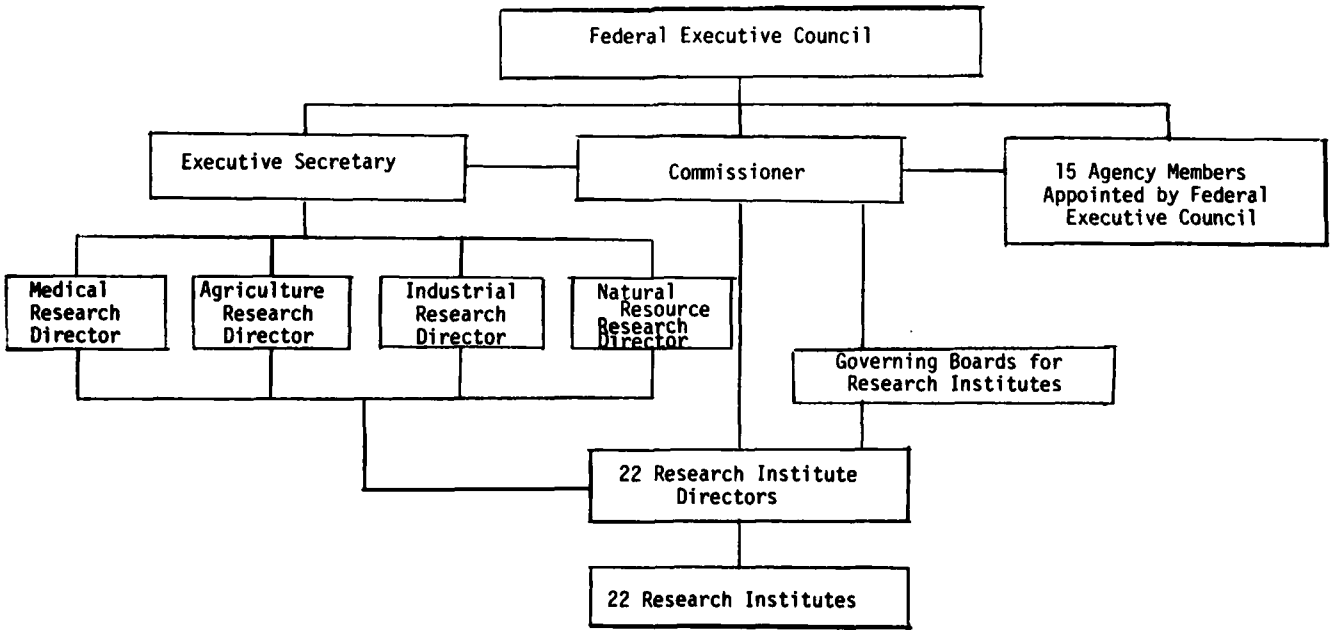
The Science and Technology Institutional Structure

Figure 7 identifies most of the Government organizations that comprise the public sector component of the science and technology infrastructure. In addition, within the private sector are a number of quality control laboratories, specialized training facilities of multinational firms, a few engineering design companies, particularly in the field of civil engineering, and some specialized analysis and service facilities. Several of the agricultural research laboratories and a few of the older university departments have received world-wide recognition for their activities. However, most of the public institutions are still in their early stages of development, and the private sector activities are directed to very special needs. One public institution with technical capabilities of particular importance is the Nigerian National Petroleum Corporation. This organization has been able to offer special salaries, high levels of responsibility, and other incentives in attracting some of the nation's best talent in geology, chemical engineering, and other technical fields.

Several universities have produced a number of exceptional graduates who have subsequently distinguished themselves at some of the best universities in Europe and the United States. They are now making significant contributions to Nigerian development in a variety of positions. Several of the agricultural research institutes have conducted pioneering research at a world level, and their findings have appeared in many international journals.

Figure 8

NATIONAL SCIENCE AND TECHNOLOGY DEVELOPMENT AGENCY (NSTDA)



However, looking at the entire system, few educational institutions are adequately staffed, and the availability and use of appropriate equipment is uneven. Outside the area of agriculture, little research is carried out within either the public or private sector. Finally, science and technology activities are greatly hampered by the absence of even rudimentary information systems in most scientific and technical areas.

At the policy level, the National Science and Technology Development Agency (NSTDA) plays a central role in the development of the nation's science and technology capability. NSTDA has line responsibility for 22 research institutes. It supports a small extramural research program at the universities and participates in a variety of other Governmental activities in fields such as manpower development and energy problems. Figure 8 describes the internal organization of NSTDA. Another agency of growing significance is the National Universities Commission (NUC) which is endeavoring to strengthen both research and educational activities at the universities.

Institutional Linkages

The Nigerian science and technology community is relatively small, and many of the key figures are close acquaintances, including some with close school ties. Further, a number of senior university officials accept temporary assignments with Government. Despite these personal relationships, the linkages among research and educational institutions and between these institutions and production organizations are spotty at best.

Transportation and communication difficulties present seemingly insurmountable barriers to meaningful institutional interactions on a continuing basis. Even the Lagos traffic jams inhibit exchanges among organizations located around the city. In no country is the co-location of related research and educational activities more important than in Nigeria. This approach is being followed for agriculture with some success in Ibadan and Zaria.

The Government research institutes were transferred from the administrative jurisdiction of the line Ministries to NSTDA in order to increase the Government's appreciation of and support for their activities. Under this arrangement, the coupling of the activities of research activities with the interests of the Ministry of Agriculture, in particular, is an obvious concern. A second concern is the coupling of the research to the interests of the State Ministries. In this regard, some of the institutes have found contracts with State Ministries a fruitful source of supplemental funding for research activities.

Government agencies are generally distrustful of multinational firms, and these firms consider Government science and technology activities, other than manpower training, to be of little relevance to their interests. At the same time, the multinational firms are obviously interested in Government procurement activities and policies which are increasingly constraining their activities. Thus, Government/industry dialogues concerning policies are frequent. However, serious efforts to cooperate in science and technology are infrequent.

EDUCATION AND TRAINING CAPABILITIES

Overview

Nigerians hunger for education at all levels. Education is considered a sine qua non to both social status and to economic well being. Despite large increases in educational opportunities in recent years, however, only a fraction of even the most highly motivated youth can realistically aspire, in the near term, to an education that will prepare them to contribute effectively in science and technology to the further development of Nigeria.

The formal education system includes a variety of activities at thirteen public universities with an enrollment of about 41,500 students, twenty polytechnical institutes with an enrollment of about 20,000 students, many teacher training institutions, a dozen trade schools, and a rapidly growing number of vocational programs offered at secondary schools. Science and mathematics are initially introduced at the elementary and secondary school levels in different forms with varying degrees of success throughout the country.

The ratio of Nigerians studying abroad to Nigerians studying at home at the university level is approximately .70. Graduate education is particularly dependent on overseas institutions. Government agencies provide several types of training for their employees which are increasingly important to operating the technical aspects of the nation's physical infrastructure. Multinational corporations offer an underutilized training potential which could be extremely important to the future development of the science and technology infrastructure.

Manpower Planning

Nigerian Government estimates of the demand for scientists and engineers are based on current vacancies in the staffing of Government agencies, the education system, and a sample of enterprises in the private and public sectors. No attempt has been made to project the growth of such activities into the future, nor to estimate personnel turnover rates. The estimates were more than one year out of date when they were released last year. In addition, a vacancy implies that the position would be filled if a qualified applicant could be found. However, a vacancy for a Government post is considered to exist if an approved position is unfilled, even if there are no funds nor intention to fill the post. Nevertheless, the vacancy approach, despite the limitations, gives some indication of those areas where the shortage of trained manpower has been particularly acute.

There are no good estimates of the capabilities and interests of scientists, engineers, or other types of Nigerian specialists in the pipeline at local and foreign educational institutions. Similarly, underemployment of scientists and engineers in Nigeria has not received adequate study. What is known is that there are considerable difficulties in filling currently available science and engineering positions in Nigeria at the salaries and under the conditions being offered. The situation is particularly apparent in the recruitment of civil engineers, secondary school teachers, and supervisory personnel for engineering projects in relatively isolated areas of the country.

The current emphasis on rapidly using petrodollars to build the nation's physical infrastructure, to expand industrial activities, and to modernize the economy has led to widespread belief that during the 1980s there will be an almost limitless need for highly trained scientific and engineering manpower. Buttressing this view are the data on current vacancies and difficulties in recruitment and retention of highly trained personnel. At the same time, many of the scientists and engineers who are now being trained will not be absorbed by the Nigerian economy in ways that effectively utilize their technical skills. The reasons for this diversion of technical talent are manyfold and include: higher pay often associated with administrative jobs; biases against employment in geographically remote areas; faster promotion opportunities in non-technical positions; and the attractiveness of living abroad. This diversion would indicate that an even greater number of engineers will be needed to fill essential science and technology positions.

However, what is really needed is a closer, more accurate look at supply of and demand for engineers in Nigeria and the Government policies and other factors that influence the effective matching of supply and demand. There is clearly a major shortage of civil engineers and an important, but less severe, shortage of mechanical and electrical engineers. (See Figure 9.) What the future portends is far less clear. Universities graduate about 150 civil engineers each year (See Figure 10.), and the current estimated shortage of civil engineers will not be filled for many years. However, as previously noted, the vacancy number is probably overstated and this projection ignores foreign sources. The less intense problem with chemical and petroleum engineers seems realistic when comparing the relative maturity of the oil production and petrochemical sectors to the large expenditures for physical infrastructure development. This situation will undoubtedly change somewhat in future years.

Figure 9

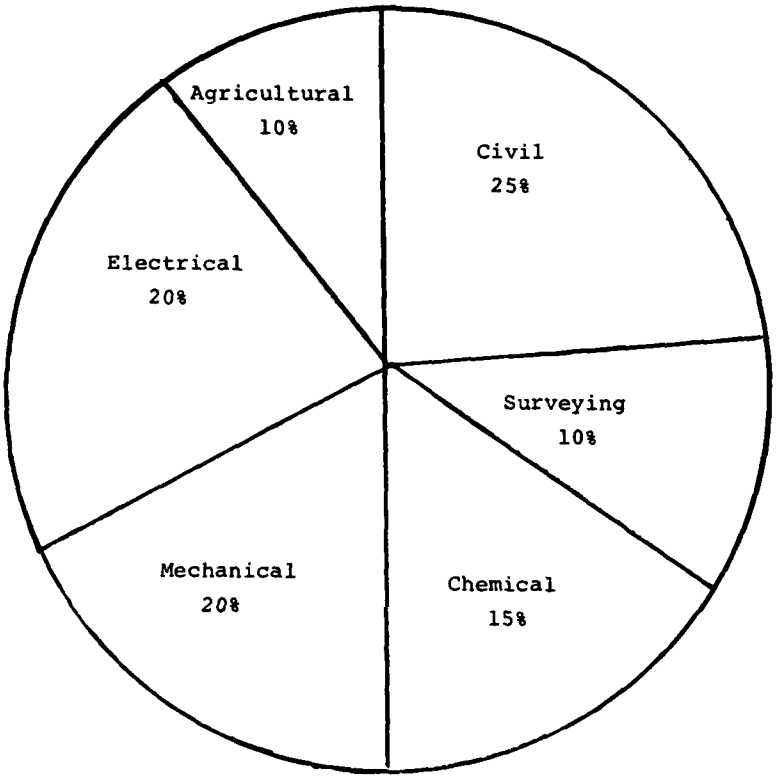
ENGINEER VACANCIES
(January 1978)

	Nigerian	Expatriate	Vacancies
Agriculture	120	12	99
Civil	7,695	374	9,617
Electrical	1,087	480	930
Aeronautical	234	109	11
Marine	283	88	122
Mechanical	885	285	587
Chemical	159	6	54
Petroleum	82	18	40
Mining	18	7	29
Metallurgical	10	1	15
Other	989	208	52
TOTAL	11,562	1,588	11,456

Source: National Manpower Secretariat, September 1978

Figure 10

ENGINEERING AND TECHNOLOGY GRADUATES
(Distribution by discipline)



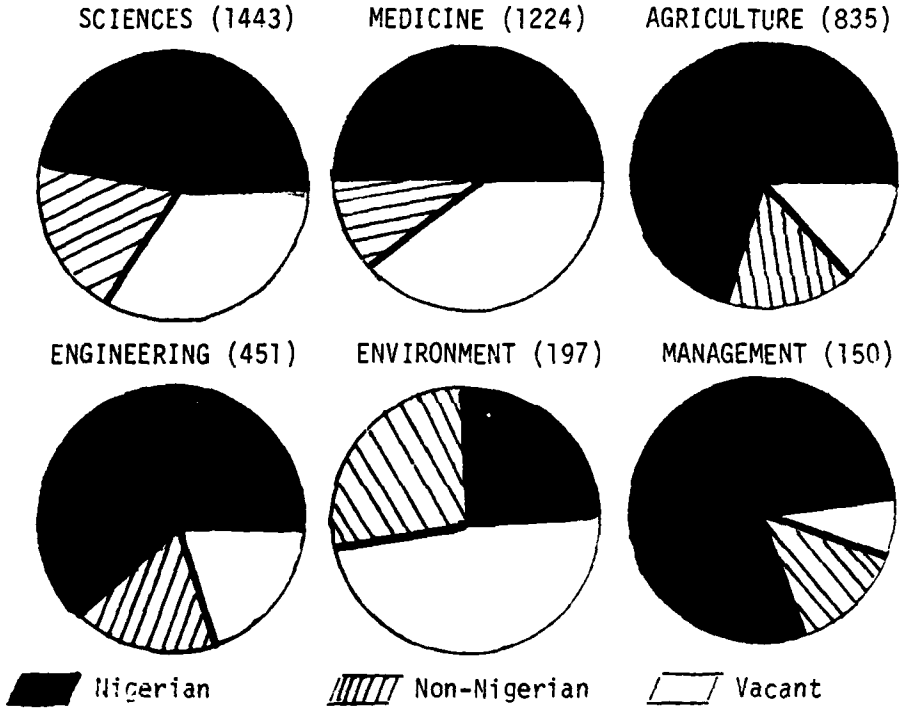
Distribution of Engineering Graduates by University

	73-4	74-5	75-6	(Projected) 76-7	77-8
Ahamdu Bello Univ.	112	115	115	121	128
Univ. of Nigeria,	55	85	83	146	164
Univ. of Lagos	52	67	86	100	109
Univ. of Ife	62	69	88	107	93
Univ. of Ibadan		8	33	54	65
Univ. of Benin		16	24	46	36
	281	360	429	574	595

Sources: "Future Nigerian-U.S. Linkages in Higher Education", American Council on Education, 5/77. Nigerian University Catalogs.

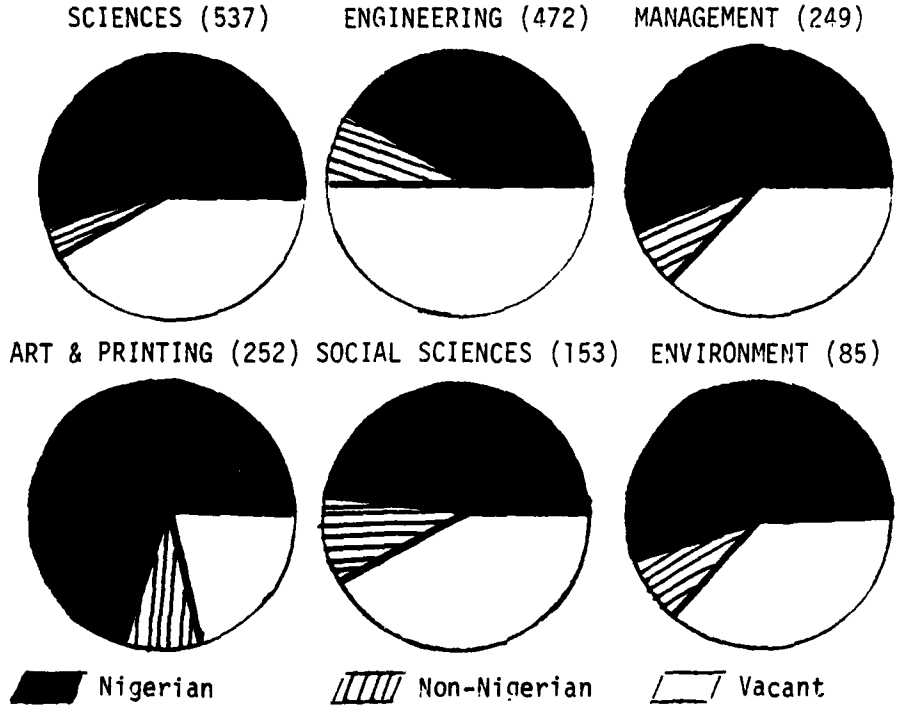
Figure 11

STAFF VACANCIES AT UNIVERSITIES AND POLYTECHNICAL INSTITUTES



SOURCE. National Manpower Secretariat 9/78. As of 4/77.

STAFFING OF POLYTECHNICAL INSTITUTES



Source: National Manpower Secretariat 9/78. As of 4/77.

Recruitment of qualified staff and students at universities and polytechnical institutes continues to plague Nigerian higher education and specialized technical institutions. Vacancies are most severe in the science and engineering faculties of polytechnical institutes, reaching 50% in some areas. (See Figure 11.) Compensation levels and social status are not adequate to motivate a high interest in teaching at polytechnical institutes and secondary school levels. In addition, students often use teacher training colleges to upgrade their secondary school backgrounds as a step toward gaining university admission. This phenomenon reduces the number of career directed teachers.

Alternative strategies both to education and to employment should be considered in order to improve the matching of technical manpower supply and demand and to realize more effectively the opportunities for application of the technical skills of educated Nigerians. For example, greater emphasis might be placed on enlarging teacher training capabilities rather than continuing to attempt to attract university-trained scientists to teach in secondary schools. Requiring teacher training college graduates to instruct for a specified number of years should be considered. Less emphasis on Government-sponsored engineering students abroad might be appropriate in view of the under-utilization of local capabilities in undergraduate engineering.

University Graduate Education

Graduate programs at the doctorate level are in their earliest stages of development. In both agriculture and engineering the capabilities (in terms of experienced faculty members, equipment, and technical staffs) for offering solid programs leading to a Ph.D. are very limited and are concentrated at only a few universities. (See Figure 12.) M.S. programs are more commonplace, but most graduate work is for diplomas for continuing education and specialized training courses.

Figure 12

CANDIDATES FOR GRADUATE DEGREES
(1976-77)

University	Arts	Education	Science	Total
Ibadan	120	26	26	172
Nsukka	42	10	10	62
Ife	172	88	213	472
Zaria[1]	N/A	N/A	N/A	N/A
Lagos	109	38	38	185
Kano	34	22	---	56
TOTAL	477	184	287	948

[1]Graduate programs exist but information was not available.

Source: National Universities Commission, Annual Report, 5/77.

The modest graduate programs should be developed slowly but steadily, recognizing that the limited demand for graduates with advanced degrees will come largely from the universities and polytechnical institutes and from a few specialized research insitutes. In the meantime, the tradition of graduate study abroad should continue to produce highly qualified scientists and engineers, some of whom will be competing in this limited employment market in Nigeria while others will seek permanent emigration.

University Undergraduate Education

In 1975 the NUC assumed responsibility for university education under the Ministry of Education. It approves all programs,acts as liaison with other Government ministries, plans new universities and expansions of old universities, and funds university expenditures.

In the 1976-77 academic year, due to a lack of communications between the universities, the NUC, and the Ministry of Finance, the universities were committed to programs which cost almost $44 million more than was finally appropriated by the Government. The NUC had not budgeted for Federal Government mandated expansions at Maiduguri and Ilorin, and the universities had not budgeted for financial responsibility for organized sub-degree institutions formerly funded by the states. Both expenditures eventually came from university budgets. Partially due to this shortfall, the three largest universities incurred debts of about $44 million. Reportedly, the universities currently have no additional sources of credit in Nigeria due to the large debts still outstanding. (See Figure 13).

Figure 13

UNIVERSITY FUNDING
(1976-77)

University requests	$466,053,000	
NUC recommendation	314,102,000	
University local income[1]	25,272,000	
Required	288,730,000	
Actual federal grants	243,800,000	
Shortfall		$44,930,000
Overdrafts		
Nsukka	$ 20,000,000	
Zaria	16,800,000	
Ibadan	11,200,000	
Total		$48,000,000

[1]Primarily student fees which were discontinued after 1976-77.

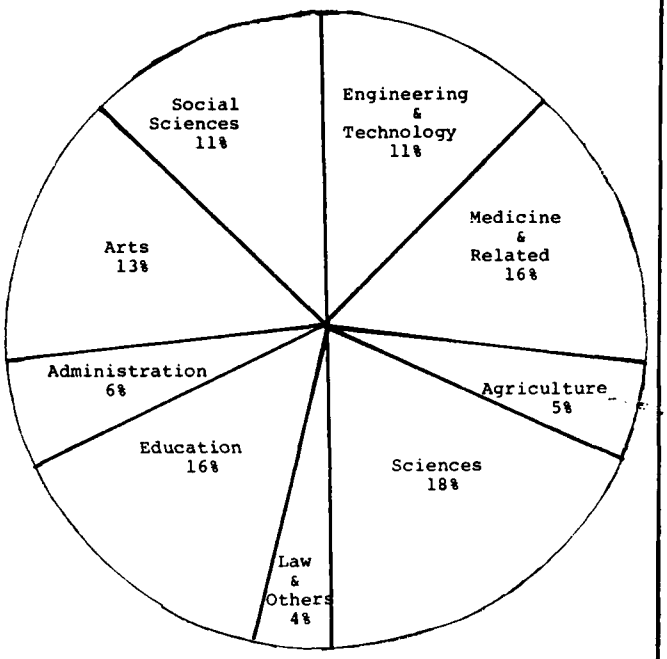
Source: National Universities Commission, Annual Report 6/77.

In response to budgetary cutbacks which reached 30 percent last year, the universities are developing a variety of ways to raise funds, including selling agricultural produce, renting facilities, and soliciting service contracts. One idea being explored by several universities is the establishment of small factories and farms at the universities which are believed to offer the potential of generating revenue and of providing facilities that can help encourage on-the-job training for students. However, there will undoubtedly be many temptations to divert attention from core academic requirements to this new dimension of university activity with the possibility of a decline in quality of the core curriculum.

Another problem, at least at the level of higher education, is the lack of interest among many top students in entering the science and technology stream, which is not perceived as a fast track to top management positions. The Government's goal for science-based university instruction is 60 percent of total university enrollment. The Government considers engineering, medicine, agriculture, and physical sciences to be science-based instruction. Under this classification system, the projection for the 1979-80 academic year is 50 percent. If medicine is removed from the classification, the projection is 34 percent. (See Figure 14.)

Figure 14

UNIVERSITY ENROLLMENT BY DISCIPLINE
(1979-80)



Note: Includes Sub-degree programs and pre-college preparation programs.
Source: National Manpower Secretariat, 9/78.

Figure 15

SCIENCE, ENGINEERING, AND AGRICULTURE ENROLLMENT
(1976-77)

University	Science Enrollment	Engineering Enrollment	Agriculture Enrollment
Ibadan	1,417	296	863
Naukka	1,294	789	520
Ife	869	659	376
Zaria	781	436	231
Lagos	543	349	---
Benin	454	239	---
Jos	121	---	---
Calabar	287	---	---
Kano	54	---	---
Maiduguri	250	---	---
Sokoto	---	---	---
Illorin	31	---	---
Port Harcourt	---	---	---
Total	6,101	2,758	1,990

The largest science-based universities are Ibadan, Nsukka, Ife, and Zaria. (See Figure 15.)

In 1976-77 there was a 6.5% shortfall in university admissions due to lack of qualified applicants. The universities had budgeted for an enrollment of 42,500, but official enrollment reached only 39,888. This reflected the shortage of qualified mathematics and science teachers at the secondary school level. The most important criterion for university admission is performance in uniform examinations given by the West African Examinations Council (WAEC). In the June 1975 WAEC examination only 13% of Nigerian candidates passed with a "C" average or better. (See Figure 16.)

Figure 16

ENROLLMENT AND EXAMINATION RESULTS

State	1975 Unofficial Census	1975/76 University Enrollment	June 1975 School Certificate Candidates (1)	June 1975 "C" or Better Results (2)	% With "C" or Better
Lagos	2.47	661	5,965	986	16.5%
Western	8.92	9,544	19,581	2,182	11.1
Mid-Western	3.24	3,829	10,565	1,179	11.2
Rivers	2.23	536	3,606	528	14.6
East-Central	8.06	8,295	17,744	3,279	18.5
South-Eastern	3.46	1,256	4,042	708	17.5
Benue Plateau	5.17	1,500	2,051	294	14.3
Kwara	4.64	2,155	3,779	384	10.2
North-Western	8.50	817	1,629	81	5.0
North-Central	6.79	1,066	2,774	242	8.7
Kano	10.90	759	1,186	64	5.4
North-Eastern	15.38	1,324	2,021	68	3.4
Total	70.76	31,742	74,983	9,987	13.3%

(1) Tests by West African Examinations Council.
(2) Passing in Divisions I and II which equates to "C" or better in the U.S.

Source: Arnold, Guy. Modern Nigeria, London: Longman Group Ltd., 1977
National Universities Commission, Annual Report, May 1977.

A large disparity exists between educational quality in different regions of the country. The North is particularly deficient in well prepared secondary school graduates and is under-represented at universities. In the past, university admission policies clearly favored certain regions. The Joint Admissions and Matriculation Board (JAMB) was recently established to consider applicants on a nationwide basis to eliminate regional bias. However, controversy exists whether to admit students proportionately based on the number of applicants (JAMB's approach) or on population. When JAMB released admission results for 1979-80 in March 1979, demonstrations at the northern universities temporarily closed those universities.

The core undergraduate engineering courses offered at Nigerian engineering faculties seem adequate by Western standards although they may suffer from overemphasis on theory. Engineers practicing in Nigeria receive little technical backup such as computers, surveyors, or draftsmen. When materials are not available, improvisation is required. The Western type university curriculum is not entirely adequate to prepare an engineer to work in the Nigerian environment where at times he must be a jack-of-all-trades. Greater emphasis is needed on problem solving and on designing and implementing projects without the benefit of modern supporting technology or imported materials. Also, knowledge of a variety of engineering disciplines may be more important in a country where there is less opportunity for formal on-the-job training and interaction with well trained colleagues. Practical steps for enriching the curriculum in these directions without sacrificing the integrity of the core engineering courses are needed.

The requirement that engineering students at universities and polytechnical institutes spend 12 months during their academic program working in industry is an excellent concept. The use of the Industrial Training Fund, which is supported by an industrial tax, to help subsidize such training seems appropriate as long as an enlarged Government bureaucracy does not become an impediment to the program. The keys to the success of this program include a commitment by the firms to provide meaningful training experiences and an insistence by the schools that the students must perform well if they wish to maintain their academic standing. In short, it must be a serious effort by all concerned and not just a vacation break from school. To this end, the Government should work more aggressively, but also with a more flexible approach as to the character of the program, through various chambers of commerce to encourage a better response to the program from industry. Improved performance guidelines for evaluating the student's activities are also needed, with the evaluation then reflected in the academic record.

Undergraduate programs in the agricultural sciences are quite well developed. However, relatively few of the students seem to have farm backgrounds, which may partially explain why the technical capabilities of many graduates are not being used in ways which effectively apply their talents in efforts to increase agricultural production. Most of the graduates apparently find employment in the Federal or State Ministries of Agriculture as administrators. Others find positions in research institutes, but few are employed to work directly in production or even field extension activities. Until larger numbers of these graduates are motivated to assume a more direct and personal responsibility for production activities, which depends in some measure on the attractiveness of job opportunities, it seems highly unlikely that farming activities will be modernized very rapidly.

The "old" universities are the primary source of science education in Nigeria. The best students, faculty, and budget appropriations are concentrated there. Although high expectations continue for the "new" universities, budgeting and manpower constraints will delay their development for a number of years. In the meantime, if significant increases in the number of graduates are considered appropriate, they can best be obtained by concentrating efforts in the established universities. The "new" universities should develop carefully, perhaps a department at a time. Linkages with the "old" universities and foreign universities might be particularly helpful during these early development phases. (See Figure 17.)

The faculty members at the older universities are well educated and generally well qualified. In some cases the faculty is spread thin, and sometimes this causes instructors to teach outside their areas of primary expertise. Instructors also find it difficult to keep current on technological developments abroad. A universal request is for collaborative programs which would bolster their ranks with short term visitors and provide them with an opportunity to spend time abroad.

Laboratory equipment is generally limited and often not well utilized. Indeed, some equipment remains in packing crates, and other equipment is inoperative. The laboratories at the University of Lagos are a showplace for new equipment, in sharp contrast with the polytechnical institutes which have poor facilities. The Universities at Zaria, Ibadan, Ife, Benin, and Nsukka are minimally to adequately equipped with individual strengths and weaknesses. However, as a general rule, all could stand significant improvement.

Figure 17

ENROLLMENT AND BUDGETS
(1976-77)

University	Year Established	Students[1]	Budget (000)	Budget per Student[2]
"Old"				
Ibadan	1948	8,457	$ 43,280	$ 5,118
Nsukka	1960	6,712	39,442	5,876
Ife	1961	5,667	32,140	5,671
Lagos	1962	5,680	38,976	6,862
Zaria	1962	7,869	42,416	5,390
Benin	1973	1,871	19,845	10,607
Subtotal		36,256	216,100	5,960
"New"				
Jos	1975	579	4,940	8,532
Calabar	1975	952	5,000	6,303
Kano	1975	1,158	6,500	5,613
Maidugari	1975	743	5,340	7,187
Sokoto	1975	---	1,600	---
Iloria	1975	200	2,720	13,600
Port Harcourt	1975	---	1,600	---
Subtotal		3,632	27,700	7,902
TOTAL		39,888	243,800	6,137

[1] Includes post graduate, sub-degree, and pre-college preparation programs.

[2] Includes capital expenditures and excludes sub-degree students.

Sources: Future Nigerian - U.S. Linkages in Higher Education, American Council on Education, 5/77. National Universities Commission, Annual Report, 6/77.

Figure 18

POLYTECHNICAL INSTITUTES

	Location	Ownership
Established Institutions		
Yaba College of Technology	Yaba	Federal
The Polytechnic	Ibadan	Oyo State
Kaduna Polytechnic	Kaduna	Ten Northern States
Auchi Polytechnic	Auchi	Bendel State
Institute of Management and Technology	Engu	Anambra State
Kwara State College of Technology	Iloria	Kwara State
College of Technology	Calabar	Cross River State
College of Science and Technology	Port Harcourt	River State
Petroleum Training Institute	Warri	Nigerian National Petroleum Company
Idah College of Technology	Idah	Federal
College of Technology	Sokoto	Sokoto State
Murtala College of Arts, Science and Technology	Kakurdi	Benue State
Kano State Polytechnic	Kano	Kano State
Lagos State College of Science and Technology	Ikeja	Lagos State
Bida College of Technology	Bida	Federal
Akure College of Technology	Akure	Federal
Imo State College of Technology	Owerri	Imo State
Plateau State College of Technology	Barankin Ladi	Plateau State
Ogun State College of Technology	Abeokuta	Ogun State
Ramat College of Technology	Maiduguri	Borneo State
Planned Institutions		
Yola College of Technology	---	Federal
Ilavo College of Technology	---	Federal
Baachi College of Technology	---	Federal
Katsina College of Technology	Zaria	Kaduna State
Niger State College of Technology	---	Niger State

Source: Federal Ministry of Education, March 1979

The Polytechnical Institutes

The polytechnical institutes were intended to provide "technologists" who have capabilities to serve as supervisors of technical operations. They are to have a limited engineering background with a heavy orientation toward the details of operational activities. The development of business and administrative skills have been added to the responsibilities of the institutes.

Twenty institutes are in various stages of development, with five more to open soon (See Figure 18.) The 1977-78 enrollment was 20,000, far below the target. An enrollment of 60,000 is projected for 1985.

Ordinary National Diplomas and Higher National Diplomas were initially issued for completion of two and four-year curricula, respectively. The Higher National Diploma only will be given in the future for completion of the four-year curriculum. This change has caused some protest among current students. Only about 12,000 students were enrolled in diploma study in 1977-78. The remainder were enrolled in short certificate courses. Only 45% of diploma candidates were enrolled in engineering, science, or technology disciplines. (See Figure 19.)

Figure 19

ENROLLMENT AT POLYTECHNICAL INSTITUTES[1]
(1977-78)

Engineering, Science, and Technology	5,417	45%
Accounting, Administration, and Secretarial	4,814	40%
Environment, Art, Printing, and Catering	1,853	15%
Total	12,084	100%

[1]Polytechnics also conduct short term in-service programs for government and industry leading to certificates. Approximately 7,000 certificates for short courses were awarded in 1977-78.

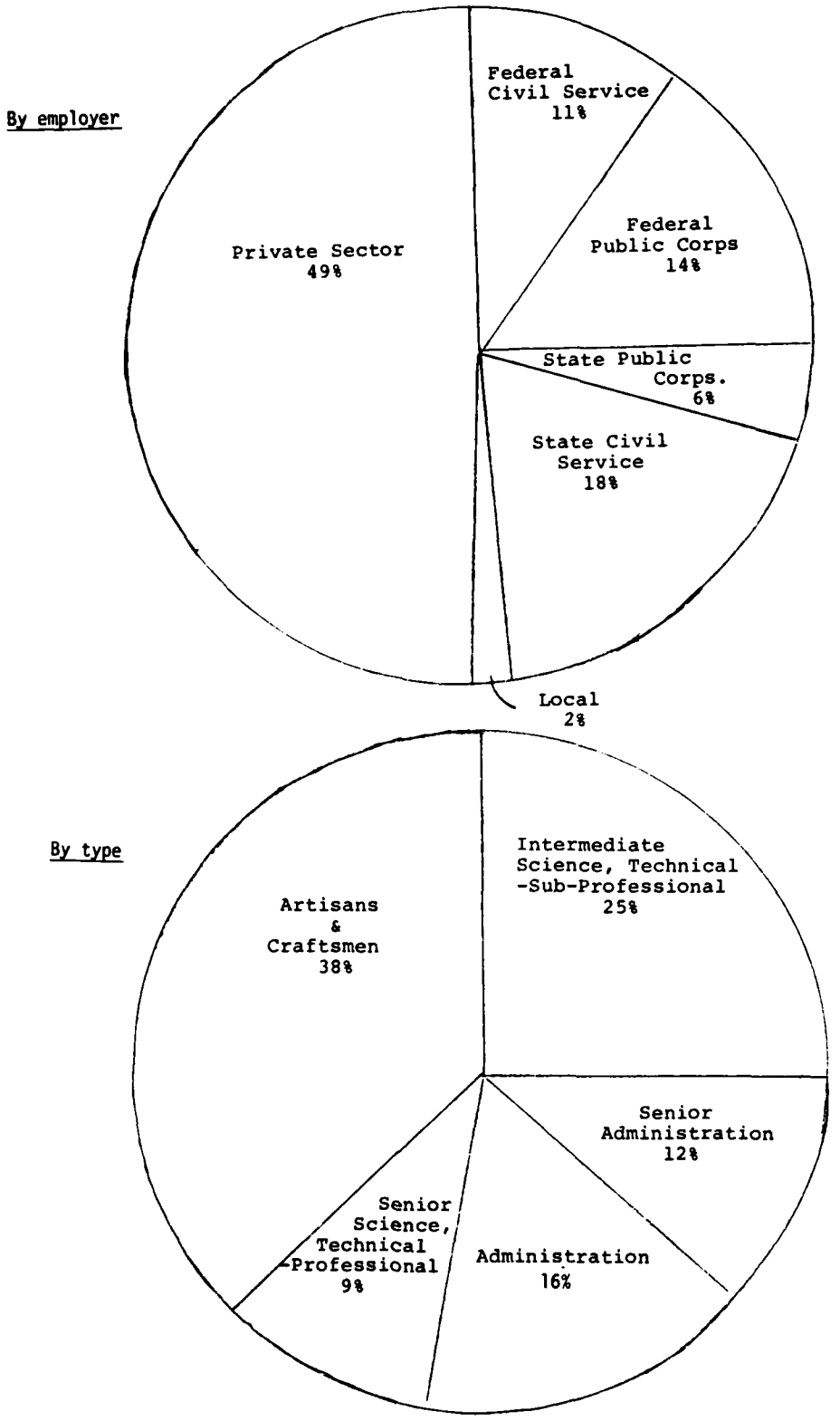
Source: National Manpower Secretariat, 9/78.

Dissatisfaction with the current system of polytechnical institutes is evident among faculty, students, and employers. The original concept of training industrial supervisors -- at a level between engineer and technician -- has not worked well in practice. Faculty and students are disgruntled because the institutes cannot award degrees. Employers are concerned over the preoccupation of some recent graduates with attempting to enroll at universities at home or abroad in order to receive degrees. Some employers hire polytechnical and university graduates on an equal basis, others make a distinction only for the purposes of pay and title, while others establish separate career tracks, e.g., operations/supervisor and engineer/manager. Still others use polytechnic graduates as high priced technicians.

Neither the faculty nor the curriculum of the institutes hold closely to the original concept. Key faculty members are often drawn from the academic community with little attention to industrial experience, and the curriculum often resembles a watered-down university engineering program, rather than an industrial training program. Further confusing the concept is the fact that one-half of the enrollees in the polytechnical institutes are majoring in business courses which may offer higher paying job opportunities. However, it is not uncommon to find

Figure 20

TYPES OF TRAINING PROGRAMS
(1976-77)



Total Trained = 28,707

Source: National Manpower Secretariat, Federal Ministry of Economic Development, September 1978.

these graduates working in mundane occupations such as hotel desk clerks.

The institutes are not adequately funded, staffed, or equipped. Overall, their role is not clear, and the entire concept is in need of careful re-evaluation. Reducing the number of institutes and affiliating the remainder with universities which would award degrees might be considered. A reduced but strengthened core of polytechnical institutes could turn out the same number of graduates but with improved abilities and motivation.

Skilled Manpower

The Government has embarked on an ambitious program of formal education to provide the bulk of the skilled manpower force needed throughout the country. Yet many, if not most, of the skills that are utilized in the country are developed through on-the-job training. Nevertheless, the Government believes that a broad base of some formal training is essential in view of the lack of exposure among the youth to technology. This formal training is concentrated in a number of trade schools and secondary level technical schools. The situation should improve, although the availability of instructors will continue to be a stumbling block as this program expands. While some training is clearly better than no training, there is a serious question as to whether this formal approach should be the principal vehicle to make a significant impact on the major problem of skill deficiencies throughout the country.

Several other types of less formal training programs are of comparable importance to the nation's capability to acquire, operate, and maintain the many technology-based systems that support the economy. (See Figure 20.) A number of the technical agencies of the Federal Government operate specialized training institutes for their employees, particularly at the skilled technician level. Secondly, many multinational companies with operations in Nigeria and, to a lesser extent local companies conduct extensive training programs for new employees, at both the engineer and technician level and offer executive training for management personnel.

The Government's mission-oriented agencies provide training for two weeks to two years in very specialized areas for employees of the organization and seem to be providing a valuable service. The railroad agency trains mechanics to repair diesels and other equipment. The electric power agency has used General Electric to train its engineers to maintain and operate new gas-powered electric turbines. Even though the training is quite specialized, the graduates of the programs often have skills that are in high demand, and they are frequently lured to the private sector by higher paying jobs.

The most effective training programs for both engineers and skilled workers are those conducted by a number of multinational corporations. These programs are located principally in Nigeria, but training at corporate facilities abroad is also commonplace. The companies have the resources to insure that the programs are tailored to individual needs, and they emphasize practical training in the field. For example, a trade certificate from Volkswagen is a passport to immediate employment throughout the country. Also, Mobil provides highly specialized training for divers, and ITT cycles a number of its professionals for 18 months of training abroad.

Government officials do not appear particularly interested in these and other private sector training activities. Indeed, they essentially ignore this capability in adopting the philosophy that Government institutions are the best hope for solving the problem of skilled labor. Perhaps the exaggerated training claims of a few multinational companies have generated a degree of cynicism among some officials.

Given the importance of skilled labor, the apparent isolation of the formal training programs from the industries which are to be the principal employers of the graduates, and the demonstrated training capability of the private sector, high priority should be given to the establishment of a nationwide apprenticeship program. Such a program could involve both one-on-one training and other types of on-the-job training -- with the industrial sector having a major voice in the design and implementation of the program. Such programs have proven quite effective in Latin America. There are currently a number of trade certification and apprenticeship schemes of varying credibility operating throughout the country, yet collectively they are not making a major impact on the nation. Only by stimulating interests of the private sector in a major way and by placing their capabilities in the center of such a program is there a likelihood that technical skills will expand at an accelerated rate.

Overseas Training and Foreign Dependence

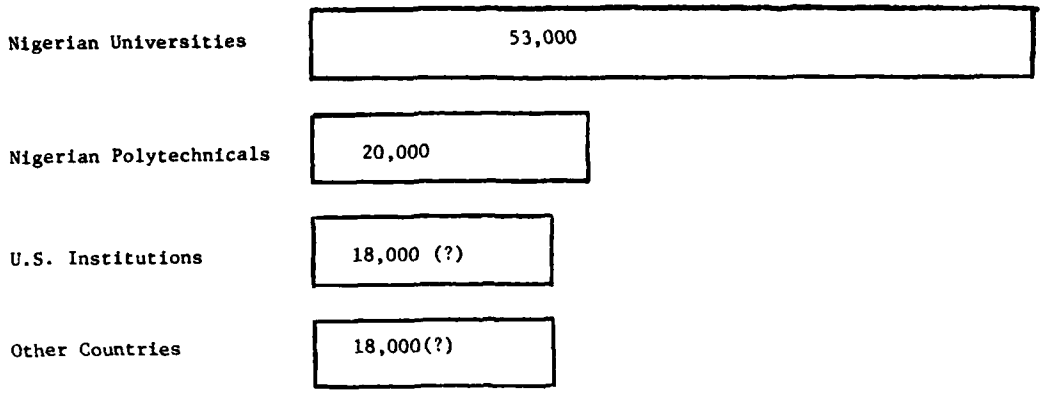
Further development of Nigeria's technological capabilities is currently highly dependent on overseas training of scientists and engineers, expatriate instructors throughout the education system, and foreign assistance programs directed to strengthening education and training capabilities. Reducing such foreign dependency is an important Nigerian objective. However, the technical lifeline to the developed world will undoubtedly be a principal ingredient in education efforts for some time.

Many Nigerian students spend six, eight, or even ten years studying abroad. Then some return to Nigeria, and others attempt to remain abroad. The longer the students study abroad, the greater the likelihood of brain drain and the more difficult the re-entry problems at home. Neither the Nigerian nor U.S. Governments should be involved in programs that encourage such lengthy stays abroad. After receiving one degree and possibly on-the-job training, the student should be required to return home and re-enter the economy. At a later date, return abroad for a second degree might be in order

The number of Nigerian students in the United States has increased dramatically in recent years. (See Figure 21.) Most of these students are supported by private Nigerian funds. A few thousand are sponsored by Nigeria Federal and state agencies, although centralized information on the number of sponsored students, the sponsoring agencies, and the fields of study is not available, even to the Nigerian Ministry of Education. A few students receive scholarships from the U.S. institutions. More than 85 percent of the students in the United States are believed to be studying at the undergraduate level. Not surprisingly, a few of the U.S. institutions where many of the students are concentrated are attempting to establish strong ties with Nigerian universities, both for professional reasons and for financial reasons (i.e., to help insure the future flow of students). To date, these ties have consisted primarily of short-term visits by faculty members to Nigeria with relatively little substantive content in scientific and technical fields.

Figure 21

NIGERIANS ENROLLED AT HIGHER EDUCATION INSTITUTIONS



U.S. INSTITUTIONS WITH MOST NIGERIAN STUDENTS

1. Howard
2. Texas Southern
3. North Texas State
4. Miami-Dade
5. Minnesota
6. Pittsburgh
7. Illinois (Chicago)
8. Nebraska (Lincoln)
9. Kansas State
10. Tennessee (Knoxville)

Sources: U.S. Embassy, Lagos; Ministry of Education; IIE 3/79

Nigeria sets high standards for applicants for admission to its universities, and many of the best undergraduate students attend Nigerian rather than foreign universities. Nigerian technical organizations also seem to be quite selective in choosing progessional staffs. At the same time, the Government seems little concerned about the qualifications of Nigerians seeking education abroad or about the standards set by overseas educational institutions. With regard to education in the United States, in particular, the only concern seems to be whether the educational institutions are accredited. Indeed, some Nigerian officials personally oppose the policy of the U.S. Embassy in Lagos to require a certain level of academic achievement by Nigerian students prior to the issuance of student visas for study within the United States. This unqualified faith in all U.S. educational institutions is particularly surprising in view of the first-hand knowledge as to qualitative differences among U.S. institutions available to many of the leaders of the Nigerian science and technology community.

Nigeria has not been successful in attracting many Americans to Nigeria as faculty members and has turned to other countries, particularly India and Eastern Europe. Primary difficulties include adequate living conditions and salary levels equivalent to U.S. salary levels. Administrative arrangements for individual recruitments have been particularly difficult. The best method for recruiting faculty members is through long-term Government sponsored collaborative programs between U.S. and Nigerian universities.

Nigerian officials have repeatedly expressed the need for internships and other types of on-the-job training within U.S. industrial organizations, particularly in design and manufacturing departments. Also, they are very interested in the placement of engineers within U.S. public sector technologies.

Foreign students who receive engineering degrees in the United States can sometimes remain for job training for up to 18 months with U.S. firms, particularly in the field of construction. Such arrangements have proved to be very

valuable. Also, a number of U.S. educational institutions offer "sandwich" courses in cooperation with industry.

There are thousands of Nigerians living abroad with a range of technical skills that could be important in the country. Relatively little effort has been devoted to recruitment of these Nigerians to return home even though some of them probably have strong family and tribal ties in Nigeria. The arguments presented by Nigerian officials concerning the difficulties of recruiting Nigerians to go home are not persuasive (salary demands, relocation allowances, housing requirements, shipments of effects) and Nigeria should carefully review the experience of other developing nations, particularly Korea, in recruiting home highly qualified scientists and engineers.

CAPABILITIES IN ADAPTATION, DEVELOPMENT, AND RESEARCH

Overview

The Government's research capability resides largely in 22 Government research institutes identified in Figure 22. These institutes vary from sizeable institutions established many years ago by the British and well known in many areas of the world, such as the Institute for Oil Palm Research, to very new institutions, such as the Building and Road Research Institute, which was formed in 1979 with an initial staff of two people.

The NSTDA budget is used largely to support these institutes and was $160 million in 1977-78. Significant resources of the institutes are devoted to activities other than research, including advanced training of staff members, extension and advisory services, and testing and analytical services. In addition to activities supported by the base budgets, many institutes carry out limited contract work for Federal and state agencies and also earn small amounts of money through the sale of products which they which they produce. (See Figures 22 and 23 for NSTDA budget information.)

The second cornerstone of the Government's research program is to be research at the universities and several polytechnical institutes. Five percent of the national budget for universities (i.e., five percent of the $270 million in 1978) is supposed to be allocated in the form of research bloc grants to the universities although actual allocations are less. Additional portions of the university budgets such as salaries of professors and supplies also contribute to research activities. Unfortunately the 1976-77 budget shortfall had its biggest effect on research, particularly equipment purchases. Research efforts begun in 1975-76 were barely maintained in 1976-77. The NUC has stated that "Nigerian universities judged on the standards of universities in other countries are relatively ill equipped for effective undergraduate and post-graduate teaching and research". Also, "provision of more modern equipment is imperative to increase post-graduate enrollment and diversify offerings at the post-graduate level". Grants for research are also received from other sources. The NSTDA has a small extramural research program ($3.2 million per year at present) which is allocated principally to university investigators. In addition, some university departments receive research support from external aid agencies.

Thirdly, the technical departments of several line agencies (e.g., Ministry of Works, Post and Telegraph, Ministry of Housing) are beginning to develop limited capabilities in design engineering and technology adaptation. Also, the quasi-Government corporations, such as the Nigerian National Petroleum Corporation, are giving increased attention to in-house capabilities in resource assessments and engineering adaptations. Indeed, oil and gas investigations carried out under the supervision of the National Petroleum Corporation involve expenditures which dwarf the scientific programs in the country. With regard to public utilities, strengthened capabilities in the public sector will reduce costly service contracts with multinational firms which are now necessary for maintenance.

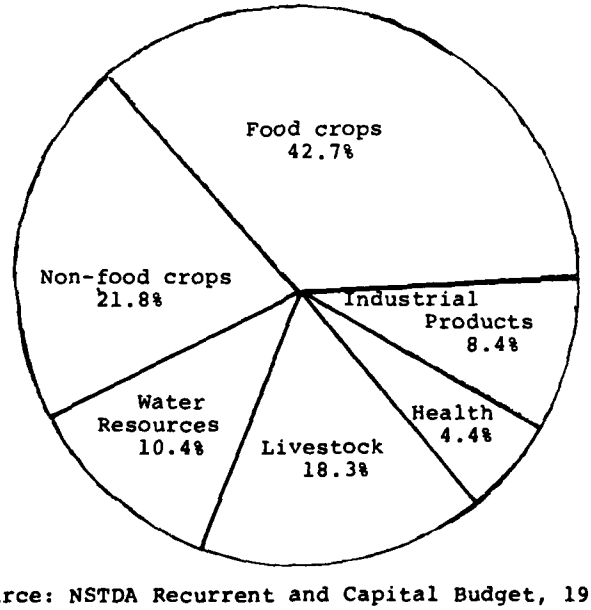
Very modest adaptive research is carried out in the private sector, principally by firms with strong international ties. For example, tires are adapted to the availability of natural rubber and to the climate and road conditions of Nigeria. Locally available materials are used in soap. Some firms are interested in introducing modern plantation farming techniques. Most of the technology introduced into Nigeria by foreign or local entrepreneurs involves only minimal changes

Figure 22
GOVERNMENT RESEARCH INSTITUTES

Institute	Location	Specialty	1977/78 (millions)
Cereals Research Institute	Ibadan	Rice, maize & other cereals	$ 16.9
Institute of Agriculture Research & Training	Ife	Low land rain forests	9.0
Institute of Agriculture Research	Zaria	Sudan and Sahel savanah zone	12.4
Horticulture Research Institute	Ibadan	Fruits and vegetables	4.8
Root Crops Research Institute	Umudlike	Cassava, yams, other root crops	10.3
Cocoa Research Institute	Ibadan	Cocoa, coffee, kolanuts	9.5
Institute for Oil Palm Research	Benir	Oil palm and other palms	8.4
Rubber Research Institute	Benin	Rubber	4.9
Agr. Extension and Research Liaison Services	Zaria	Information and extension	2.0
Stored Products Research Institute	Lagos	Storage & preservation	3.2
Forestry Research Institute	Ibadan	Forestry & wildlife	11.6
Lake Chad Research Institute	Maiduguri	Resources of inland lake	3.0
Kainji Lake Research Institute	Kainji	Resources of man-made lake	6.1
Institute for Oceanography & Marine Research	Lagos	Oceanography & marine resources	7.4
Animal Production Research Institute	Zaria	Livestock production	4.2
Veterinary Research Institute	Jos	Livestock diseases	11.9
Institute for Trypanosomiasis Research	Kaduna	Trypanosomiasis	7.2
Leather Research Institute	Kaduna	Leather utilization	6.0
Institute for Medical Research	Lagos	Medical research	7.0
Federal Institute for Industrial Research	Lagos	Food science & related fields	5.5
Projects Development Institute	Enugu	Engineering design & development	7.8
Building & Road Research Institute	Lagos	Materials, design and construction	0.0
			$159.1

Source: NSTDA Research Institutes Approved Recurrent & Capital Budget, 1977/78

Figure 23
DISTRIBUTION OF BUDGET AMONG RESEARCH INSTITUTES



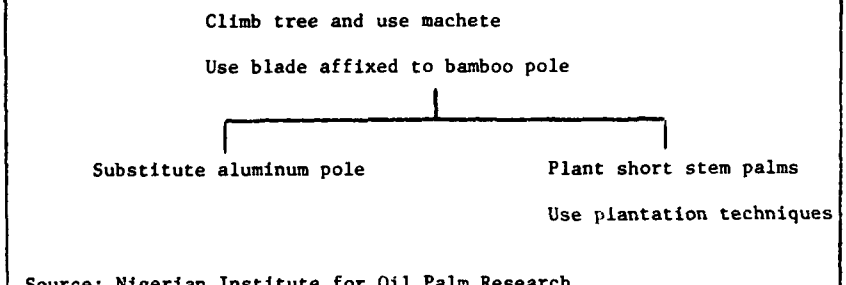
Source: NSTDA Recurrent and Capital Budget, 1977/78

from technologies that have been proven elsewhere. Most of the engineering expertise for facilitating the introduction of even proven technologies still resides within the international firms with operations in Nigeria and with expatriates employed by local firms.

All of these organizations are involved in choosing or providing advice on technologies that are best suited to the local environment. Figure 24 presents a choice facing a research institute, and Figure 25 describes a local private sector effort to move from technology acquisition abroad to local manufacture. Another interesting example facing Government agencies is the development of a local communications industry as shown in Figure 26.

Figure 24

HARVESTING OF OIL PALM FRUIT



Source: Nigerian Institute for Oil Palm Research
3/79

Figure 25

PRODUCTION OF REFRIGERATORS

Import refrigerators
Assemble refrigerators
Use local materials in assembly process
Manufacture selected components
Assemble/manufacture compressors and evaporators
Design refrigerator modifications

Source: Thermocool Engineering Ltd., 3/79

Figure 26

DEVELOPING THE COMMUNICATIONS INDUSTRY

Existing system

- Improve operations
- Expand coverage
- Reduce reliance on expatriates

System components

- Assemble phone sets and PBXs locally
- Manufacture selected components

Adaptive research

- Reduce system susceptibility to corrosion, humidity, termites
- Clarify local atmospheric propogation characteristics

Government Research Institutes

In the agriculture field, research activities are being carried out in a number of areas at a level that compares favorably with research in the developed countries. Despite this effort, agriculture production has stagnated, and few of the advances of modern science and technology are reflected in production activities. Paradoxically, in the industrial area where production is rapidly expanding, the Government's capabilities in research and technology as well as the interest of the private sector in innovation are very low.

Agriculture research is only part of the agriculture production system. There are millions of small farmers tilling small farms. Reaching farmers through extension services with new techniques, new plant varieties, loans, and market information is difficult and not well developed. Planning and administering new programs on a large scale is still beyond the capability of relatively new state agencies. Additionally, technical manpower is in short supply in the field.

The agriculture research institutes are confronted with the multiplicity of problems. The research staffs are well trained, but they are short on experience in a number of areas. There are more varieties of plant disease, insects, and weeds in the tropics than anywhere else in the world. There are hundreds of soil types ranging from acid forested soils in the South to dry, high base status soils in the North.

Figure 27 identifies specific crops of research interest. The highest priority should probably be given to major grain and root crops as well as potential export crops. However, historically, there has been a major gap between laboratory research objectives and the capabilities of small farmers to use research results, and only recently has research on farming systems begun to receive attention. Also, the inadequacy of research is less of a constraint to increased agricultural productivity than pricing policies, availability of credit, and land tenure.

Figure 27

CROPS OF RESEARCH INTEREST
(illustrative)

Maize	Soybeans	Spinach
Wheat	Coypea	Irish potato
Sorghum	Cocoyams	Sweet potato
Millet	Groundnuts	Cocoa
Cassava	Soya beans	Coffee
Yams	Cotton	Kolanuts
Oil palm	Kenaf and Roselle	Rubber
Raphia palm	Onions	Citrus
Coconut palm	Tomatoes	Mango
Date palm	Peppers	Cashew
Sugar cane	Okra	Pineapple
African yam beans	Garden egg	Avocado
	Carrots	Rice

Source: NSTDA, IITA, NAFPP publications

The International Institute for Tropical Agriculture (IITA) is working under contract with the Nigerian Government in efforts to upgrade agriculture production on a nationwide basis through the National Accelerated Food Production Program (NAFPP). This arrangement is intended to provide a new channel for introducing scientific and technical concepts more fully into production activities. Also, this direct link to production is designed to help break the academic isolation that tends to surround international centers. The success of NAFPP depends on the underdeveloped state agriculture planning and extension services. After several years of effort, some skepticism over the success of NAFPP has arisen. However, even if expectations are not met, the linkage between the Nigerian Government and the IITA and the new approaches to extension could prove valuable in the future.

The Government's industrial research institutes are in their earliest stages. They concentrate principally on adaptation and improvement of very simple technologies of interest primarily to a few small entrepreneurs. They also perform some quality control work and testing for local business and Government agencies on a fee basis.

Indeed, by Western standards few of their activities would be classified as research, but would more appropriately be called technology services. The staffs are not very experienced - either technically or from an economic perspective - even in the areas in which they are operating. Thus, it is not surprising that the number of institute developments that have been introduced into commercial activities is very small. There has been some success in introducing improved methods for the manufacture of bricks and for improving the quality of local dyes.

Commercialization of research results does not seem to command a high priority within the industrial research institutes. Indeed, the first priority usually is to achieve a research success, and only then do the economists become seriously involved in trying to assess the commercial viability of the discovery. Even in dealing with intermediate technologies, the potential users of the research are not brought into the assessments until rather late in the development cycle.

Rarely can research results be sold or even given to commercial enterprises which have not been involved in a significant way in their development. In short, until the private sector becomes a more integral part of the research process, the likelihood that research results will be commercialized is low. The Manufacturer's Association of Nigeria and various chambers of commerce might be an underutilized resource for bringing local industry into the mainstream of Government research in a more meaningful manner, but it seems clear that much of the initiative must come from the institutes themselves.

There have been unrealistic expectations in many countries, including Nigeria, as to the likelihood that Government industrial research institutes are in a position to develop products and processes that will be adopted by private industry. Rather, their importance is largely in the area of service. They provide the Government with a potential capability to assess foreign technologies that are being considered for acquisition; the the Ministry of Industries apparently intends to call upon their resources in examining proposed technology transfer agreements in the future. They can be important information hubs, acquiring and disseminating information of interest to many parties and particularly small entrepreneurs. They provide a testing and analysis capability which can be used by Government agencies and small enterprises. Finally, they serve an unplanned educational function in providing post-graduate training for scientists who spend

short periods of time in the institutes prior to seeking employment at higher salaries in the private sector.

As Nigeria develops its own production capabilities in petroleum and steel and expands its exploitation of coal and other mineral resources, a stronger technological capability seems essential. Such a capability should assist in decisions and activities directed to the acquisition, operation, and maintenance of modern technological processes. Since these activities will presumably be conducted largely by public sector enterprises, a Government laboratory with strong capabilities seems appropriate - a laboratory of far higher quality than any other laboratory in the country today. Presumably the planned National Technology Development Center will be oriented toward the material sciences and might fit the specifications suggested above. The Center should be co-located with one of the university engineering facilities to provide a coupling of research and educational activities and to provide the opportunity for sharing expensive equipment and libraries. Also, consideration should be given to establishing the Center as a quasi-Government body with pay scales comparable to those of the Nigerian National Petroleum Corporation. Without the ability to attract first class people, the viability of such an organization seems questionable.

University Research

Research is performed at all of the established universities in varying degrees, but budgeting and related problems have limited the efforts. Many scientists at the universities are anxious to become involved in serious research endeavors in addition to their teaching efforts. Such research is important if graduate programs in science and engineering are to provide students with meaningful training. The potential for research at universities is illustrated by research interests of the staff at the University of Nigeria, Nsukka. (See Figure 28.)

There has been an upsurge of university interest in intermediate technologies. Such activities can provide useful problem solving experience for engineering students.

The Government recently decided that while consideration of nuclear power was premature, development of a nuclear research capability at two universities was in order. As these universities gain experience, they will be important resources in providing advice to the Government as to future policies in this area.

Activities of the Private Sector

Local industry conducts almost no research or development activity at present. Modifying product lines in response to consumer preferences, adjusting the capital/labor mix in production processes, and adjusting the mix of local/imported raw materials represent the extent of innovative activities in most firms. A few of these firms are interested in moving into the design engineering phase, and this trend should be encouraged.

Current protective measures against foreign imports have had some impact in encouraging indigenous industrial development, but the Government incentives for research (e.g., cash prizes for success stories and tax deductions for research expenditures) have not yet resulted in discernible activities. The promulgation and enforcement of product standards for selected consumer products (e.g., food, batteries, mechanical and electrical items) have resulted in some firms upgrading the quality of their producrs. This effort of the National Standards Organization needs strong support. (See Figure 29 for a summary of Government measures to encourage indigenous technology developments.)

Figure 28

RESEARCH INTERESTS AT UNIVERSITY OF NIGERIA, NSUKKA

Civil Engineering	Soils, erosion.
Electrical Engineering	Projections of electricity demands.
Agricultural Engineering	Relevant machines for production and storage of agriculture products.
	Solar energy study [NSTDA].
Agriculture	Interdepartmental team studies for rural development; gathering information on socioeconomics, land tenure systems, social attitudes.
Food and Home Sciences	Food problems.
Veterinary Medicine	Field studies on animal diseases and effectiveness of [imported] drugs.
Zoology	Parasitic diseases [hookworms, filiarisis, guinea worms]. Hydrobiology for fisheries.
Biochemistry	Enzymology. Microbial chemistry. Nutrition Toxicology of cassava and herbicides. Storage of agriculture products [with Nigerian Institute for Root Crops].
Pharmacy	Composition and uses of medicinal plants. Uses of local plant products: starch as binder; oil as lubricants.
Botany	Physiology of root parasites [witch weed] which devastate corn fields [Rockefeller]. Roots and tuber storage. Seed propagation. Oil palm germination [student at NIFOR]. Uses of timber. Food preservation. Hybridization of plants.
Chemistry	Synthesis of heterocyclics [exchange information with Harvard]. Inorganic-organic liquids. Natural products. Plant extracts [with Pharmacy].
Physics	Theoretical particle physics. Astrophysics [33 ft. antenna ordered from University of California]. Energy grants from UN, NSTDA, NUC.

Source: University of Nigeria, Nsukka, March 1979.

Figure 29

MECHANISMS TO STIMULATE INDIGENOUS TECHNOLOGICAL DEVELOPMENT
(illustrative)

Limitations on Technological Dependence
- restrictions on imports
- required use of local materials
- required use of locally made components
- requirements for standard product lines

Incentives for Indigenous Innovation
- tax holiday for pioneer industries
- tax deductions for R&D expenditures
- cash prizes for successful innovations

Government Services
- government certification of product quality
- R&D in government labs and universities
- extension services of government agencies and universities

Sources: Ministry of Industries, Ministry of Economic Development 3/79

The multinational companies operating in Nigeria conduct few activities that could be classified as adaptive research. Most of these activities relate to the use of local raw materials (e.g., woods, fibers, fats) and the adaptation of products and processes to the tropical environment (e.g., humidity, termites, flooding). The Government realizes that multinational corporations are a major source of technology, but is still searching for effective means for drawing on this technology capability.

An important development is the requirement for local manufacture of components for motor vehicles. The multinational firms will of necessity work with a range of suppliers to insure that their technology processes will produce products that meet relatively stringent specifications.

The Ministry of Industries will establish an Office for Technology Transfer in 1979 to coordinate all approvals required for imports and investments. The normal approval process will include review for the appropriateness of technology, manpower training aspects, impact on indigenous industry, spare parts and service provisions, expatriate staffing, and repatriation of profits. Figure 30 summarizes several of the criteria in considering technology transfer arrangements.

Figure 30

CRITERIA FOR FOREIGN INVESTMENTS AND LICENSES

Increase exports or reduce imports.

Create new industry, introduce new processes, or transfer know-how.

Increase local employment

Source: Questionnaire for Non-Resident Capital Investment, Ministry of Finance, 3/79

The advent of the petrochemical industry provides an opportunity for Nigeria to draw on the strengths of multinational firms to establish an important industry and at the same time begin to develop its own capabilities in this field. There seems to be a tendency toward a public sector enterprise although it is not clear that such an approach will be more effective than a private sector or mixed undertaking with local and foreign equity ownership. In any event, involvement of foreign enterprises through ownership or through contracts should include substantial training requirements.

The Government is making a special attempt to induce multinational activity in agricultural activities. The National Grains Production Company was established in 1975 to implement grain reserve, production, and processing programs. The production program envisions large mechanized farms operating as joint ventures between state Governments and private investors. (See Figure 31 for some of the incentives.) To date, two farms are underway - one Government effort at Mokwa and one joint venture in Bendal State. Two other projects are under study by private groups. It is too early to tell whether any of these projects will develop according to plans. Similar schemes have been discussed for palm oil and rubber production.

Figure 31

AGRICULTURE INCENTIVES

Financial

- Agriculture Credit Guarantee Scheme
- Nigerian Industrial Development Bank
- Nigerian Agriculture Bank

Tax

- Pioneer status--five year tax holiday
- Indefinite loss carry-forward
- Abolition of import duties on implements intended for agriculture production
- 100% tax exemption on interest income from agriculture loans by commercial banks
- 10% first year bonus depreciation

Other

- Supply of fertilizer at a 10% subsidy

Source: Project Identification Report, U.S.D.A., November 1978

Information and Extension Services

All levels of Nigerian economic, scientific, and technical activity could benefit from improved access to reliable information. For example, the Third National Plan presented overly optimistic estimates, and future plans will be similarly unrealistic without more accurate, reliable, and timely statistical and resource survey information. In another area, researchers are unaware of related activities being conducted abroad, and research duplication cannot be avoided. Figure 32 underscores some of the information deficiencies with particular reference to the agriculture sector.

Figure 32

INFORMATION DEFICIENCIES

General

- Population size and characteristics
- Quantity and character of natural resources
- Number and types of enterprises
- Annual production figures
- Alternatives available for use of natural and human resources

Agriculture

Conditions and trends	Soil maps
Agriculture production	Land use
Marketing consumption	Cropping patterns
Prices	Agro-climatic conditions
Stocks	Drainage and irrigation
Rural living conditions	Land productivity

Source: Project Identification Report, U.S.D.A., November, 1978.

Available information is often fragmented and uncataloged. A primitive publication capability limits reproduction and distribution of information. Also, concerns over theft inhibit development of an active library system with significant outreach programs.

The current emphasis on establishing large documentation centers at the national and the state levels needs careful assessment, with particular attention directed to how such centers will be coupled to the users of information. Perhaps specialized, national communication centers should be formally designated as adjuncts of the responsibility of the principal research centers for the topics of concern. For example, NIFOR already operates as a national information service for palm oil, and this type of responsibility could be formally assigned to other NSTDA institutes for their fields. Such a responsibility would provide additional opportunities for these institutions to work more closely with the production organizations. In the area of information related to manufacturing, the chambers of commerce or the Nigerian Association of Manufacturers might be given a national information responsibility in view of their close ties with industry. Meanwhile, the university libraries need considerable strengthening to adequately meet

their educational responsibilities. As an example of the seriousness of the situation, all subscriptions to foreign journals were cancelled for over one year at the University of Nigeria due to budget cuts.

Agriculture extension schemes draw on good research work. However, state extension services are not well staffed. Despite the availability of relevant information, they have difficulty capturing and retaining the attention of the farmer. One step to improve the integration of research, extension, and production is the National Accelerated Food Production Project which is a comprehensive approach to increasing agricultural productivity.

The University of Ife with AID-financed help from Georgia Institute of Technology has pioneered the development of industrial extension services. An early activity was cataloging business enterprises in the surrounding area. This program now operates offices in Aybar, Bendal State; Ife, Oyo State; Adoiekiti, Oyo State; and Ilorin, Ogun State. Information has been distributed regarding financing options, appropriate equipment, plant heating design, and physical plant layout, to name a few areas. Fees are based on ability to pay, and a profit has resulted since inception. Fifty-two clients were served during 1978. The Government is considering extension of this program to other universities. To complement this program, NSTDA and UNESCO are contemplating a central data bank at the University of Ife to accumulate information on imported and local technologies.

Also underway at the Univeristy of Ife is a program combining business, Government, and university resources. One project is development of a large tomato farm and a tomato puree factory at Auchi, Bendal State, with participation of the Auchi Chamber of Commerce, Bendal State, and the Federal Government. The project may be too ambitious at this time, but the concept behind this type of linkages should be promoted.

Other methods to disseminate technology information are in various stages of planning. The most ambitious scheme is a network of Industrial Development Centers, each with some type of documentation center and specialized library. The centers would probably be consulting centers for small industry with the well known problems of retaining high quality staff and effectively interacting with local entrepreneurs. The NSTDA hopes to begin publishing specialized journals in agricultural, industrial, medical, and natural science technology, although the audience for these publications remains to be clearly defined. Trade fairs and seminars of the chambers of commerce can provide local business with information from domestic and international sources. Finally, a Research Products Development Company has been proposed to help remedy the often criticized absence of efforts to translate research reports into actual production.

Almost all of the foregoing activities are designed to increase the availability of technical information. Far less attention has been given to increasing the demand for information among production organizations.

Other Supporting Services

The Patent Office serves primarily to protect technology developed abroad. Many filed patents have never been used; others were registered after having expired in the country of origin. In both cases the diffusion of technologies can be inhibited. Meanwhile, Nigerian enterprises pay royalties and licensing fees for the use of patented technology. Nigeria recognizes its very limited technical ability to evaluate patent claims, and the government is hopeful that the activities of the United Nations will provide some guidance to the approach in the area of patents. (See Figure 33.)

Figure 33

PATENT APPLICATIONS

Year	Resident[1]	Non-Resident[2]	% By Resident
1975	6	401	1.5%
1976	8	428	1.9%
1977	4	296	1.4%
1978[3]	2	298	0.7%

[1]No resident patent is being worked.

[2]Filed by foreign companies and previously filed in country of origin.

[3]Through August 1978 only.

Source: Registry at Patents and Design, Ministry of Trade, Lagos (Compiled by F.N.C. Oragwu).

Standardization of selected capital goods to provide sufficient demand that will support production of spare parts in Nigeria is a goal of the Government. The Government hopes for a three-fold benefit through increasing domestic production, facilitating repair of imported equipment, and moving closer to domestic manufacture of some imported equipment. However, little progress has been accomplished in this direction. For example, several types of motor vehicles are assembled in the country from imported parts (Volkswagen, Peugeot, Styr-Daimler Puch, British Leyland, and soon Fiat), and many others are imported despite import duties of about one hundred percent. In short, competitive forces are strong in Nigeria, and standardization of products appears to be far into the future.

The Nigerian Standards Organization is a young but important organization. The product standards that have been established have provided reassurance to consumers and has forced an upgrading of the production activities of some firms.

Quality control activities, while still very limited, have expanded rapidly in recent years, in response to both Governmental and market pressures. Many local firms have testing facilities, and others use the facilities of the universities and research institutes. Specifications for Government contracts are becoming more rigorous, and the monitoring capability of the technical departments of procurement agencies is gradually improving.

Maintenance and Repair Problems

Nigeria's very limited capabilities to service and repair equipment are concentrated largely within the public and private sector organizations which operate the equipment. These organizations, frequently unable to find adequate service

facilities in the private sector, are increasingly developing their own maintenance crews, installing auxiliary power supplies, and building stocks of spare parts. When faced with difficult problems, these organizations usually call in expensive expatriates with whom they have established formal or informal consulting arrangements.

Of course, the smaller entrepreneurs are not able to support in-house service groups and face many difficulties in relying on other organizations to cope with the problems of repair and spare parts. Long delays while waiting for parts or technicians and early obsolescence due to inability to repair equipment impose severe costs on a large scale. Action in the education sector and in industrial regulation seems to be the only answer. The problem will not be quickly or easily resolved.

The lack of technical capabilities is reflected in the operational status of research equipment as well as in frequent shutdown problems throughout industry. Since there seems to be no solution on the immediate horizon, research facilities should be encouraged to have their own auxiliary power and water supplies, their own maintenance shops and staff, and their own stocks of spare parts. Indeed, this on-site supporting capability probably deserves a higher priority than any expansion of scientific activities.

U.S. GOVERNMENT ACTIONS TO INCREASE OPPORTUNITIES FOR COOPERATION

Neither the Department of State nor any other U.S. agency is well informed on scientific and technical developments in Nigeria. Indeed, even a list of activities within the country funded by U.S. agencies is not available. The U.S. Embassy in Lagos plans to increase its attention to science and technology, but this step will only be effective if there is a comparable increase in interest within the Department of State.

A Science Attache stationed in West Africa, with a major responsibility for Nigeria, could help fill the information void. When the new Institute for Scientific and Technological Cooperation comes into being there will be an even greater need for a focal point for sorting out U.S. science and technology interests in the area, insuring a degree of coordination, and stimulating programs in gap areas. In order to have credibility, the Science Attache should have at his disposal a small discretionary fund, perhaps on the order of $50,000 to $100,000 per year, for travel grants in both directions for high priority targets of opportunity.

Nigerian officials seem receptive to informed criticism and constructive proposals concerning the application of science and technology. For example, Nigeria has recently hosted a number of U.S. survey missions to examine various aspects of Nigerian development. (See Figure 34.) However, the science and technology circuits in Nigeria are currently overloaded with U.S. expertise. Prior to pressing forward with additional survey missions such as the one proposed by the National Science Foundation, U.S. agencies should carefully review available reports and recommendations.

Figure 34

RECENT AID-FINANCED SURVEYS IN NIGERIA
(illustrative)

Topic	U.S. Agency
Environmental Pollution	EPA
Housing Development	AID
Inland Waterway Development	Corps of Engineers
Statistical Services	Bureau of Census
River Basin Development	Department of Agriculture
Buildings & Roads for National Capital	GSA/NBS/FHWA

Source: AID Office of Reimbursable Development Programs
1/15/79

An encouraging development to bring better coherence to U.S.-Nigerian interactions in science and technology is the recent establishment of a broadly based non-Governmental committee of Nigerian and U.S. scientists and engineers to analyze

critical problems, sort priorities, and stimulate needed programs. The first workshop organized by the Committee in New York in April 1979 elicited an enthusiastic response on both sides. The U.S. Government should provide the very modest funding required for the U.S. secretariat and for travel of U.S. participants so that the momentum that has been built up on both sides is maintained.

The program of the International Communications Agency (ICA) for bringing visitors to the United States, while quite limited in the area of science and technology, is nevertheless one effective mechanism for promoting cooperative endeavors. Also, the Fulbright model for promoting cooperation should be carefully considered, particularly as the Institute for Scientific and Technological Cooperation considers appropriate mechanisms for facilitating scientific and technical exchanges.

The U.N. agencies offer limited opportunities for U.S. institutions to participate in development activities in Nigeria. For example, Temple University and the State University of New York at Buffalo are conducting off-campus graduate programs in Nigeria in the field of education under a UNDP/UNESCO program. The problem is that few Americans know about U.N. activities in Nigeria, and still fewer know how to become involved. (See Figure 35.)

Figure 35

UNDP PROJECTS IN NIGERIA

	No. of Projects in Various Stages	UNDP Contribution	Nigerian Contribution
Agriculture, Forestry & Fisheries	44	$20.9 M	$24 M
Education	18	13.3	13.3
Economic & Social Policy	10	4	3
Health	8	4.3	3.8
Industry	25	7.3	96.3
Labor, Management, Employment	3	3.0	8.6
Science & Technology	8	3.3	3.8
Social Services	5	4.1	2
Transport & Communications	11	10.8	8.8

Note: Some projects are still active only on paper.

Source: UNDP Projects Report, June 30, 1978.

The reinstitution of AID programs in Nigeria -- scheduled for FY 1980 -- should offer new opportunities for U.S. involvement in Nigerian agricultural development. At the same time, however, there is a clear possibility that such a program will become the principal U.S. mechanism for identifying, developing, and funding cooperative efforts. As such, it could become a hindrance to potentially important exchanges which do not conform to narrowly conceived and complicated AID guidelines. For example, with regard to AID's concentration on agriculture, such an emphasis could inadvertently divert U.S. attention and skills from the need for a more geographically dispersed industrial base to help stem urban migration, the need for development and processing of natural resources to provide employment opportunities, and the need to upgrade drinking water to reduce the incidence of disease. While AID funding can support an important component of U.S.-Nigeria relations, AID should not become the focal point within the Government for cooperation in science and technology.

Well informed U.S. observers of the Nigerian agricultural scene based in Lagos contend that even though AID made substantial investments in improving agricultural production during an 18-year period, the impact of these investments on agricultural production is nowhere to be seen. Of course, many impacts of AID programs can be detected throughout the educational and research institutions. If AID intends to re-enter the field of agricultural production, even in a very indirect way through support of education and research, high priority should be given to re-visiting and analyzing some of the earlier major AID investments intended to increase agricultural productivity.

During the AID years, a number of U.S. universities established "linkages" with Nigerian universities, particularly in the fields of agriculture and education. (See Figure 36.) These linkages consisted principally of Nigerians studying in the United States and American faculty members teaching and providing technical assistance in Nigeria. The U.S. universities that were involved were among the best, the funding for most of the endeavors was in the millions of dollars, and these programs generally succeeded in giving the Nigerian institutions a major boost. The new universities could benefit most. For example,

FIGURE 36

PAST LINKS BETWEEN U.S. AND NIGERIAN UNIVERSITIES

U.S. UNIVERSITY	NIGERIAN UNIVERSITY	SPONSOR	DATES OF AGREEMENT	OBJECTIVE	FIELD
Iowa State University	University of Nigeria	FORD	1963 1975	Faculty Development	Education
Johns Hopkins University	University of Lagos (Institute of Child Health)	AID	1971-1976	To improve & expand health education	Public/Family Health
" " "	" "	FORD	1977 ---	" "	" "
Kansas State University of Agriculture & Applied Sciences	Ahmadu Bello University	AID	1961-1977	Faculty Development	Agriculture and Veterinary Medicine
Michigan State University	University of Nigeria	AID	1960-1969	University development: planning & staffing	Various fields & Continuing Education
New York University	University of Lagos	AID	1961-1970	Faculty Development	Business Administration & Social Studies
Teachers College, Columbia University	University of Lagos (College of Education - became Faculty of Education in 1976)	AID	1971-1976	In-service programs: Professional Studies; Education Leaders Program	Education
University of California at Los Angeles	Federal Advanced Teacher Training College - merged with U. Lagos' College of Education in 1967	AID	1961-1968	Teacher Training college, department of education and college library	Education/Teacher Training
University of Massachusetts University of Connecticut	University of Ife (Institute of Administration)	AID	1971-1976	Training in project analysis	Public Administration
University of Pittsburgh	Ahmadu Bello University	AID	1962-1973	To strengthen and expand institute	Administration and Business Management
University of Wisconsin	University of Ife	AID	1964-1975	Faculty Development	Agriculture
" "	Ahmadu Bello University	FORD	1962-1968	Primary Teacher Training Program	Education/Teacher Training
Washington University	University of Ife	FORD	1970 ---	Yoruba Primary Curriculum Development	Education/Bilingual

Source: "Future Nigerian-US Linkages in Higher Education" American Council on Education 5/9/77

the University of Port Harcourt is seeking a collaborative arrangement with a U.S. university in the field of petroleum engineering. It is hard to conceive of a more fertile area for active U.S. Government support. "Relevant" technologies are of great interest to Nigerian universities (e.g., agricultural machinery, small-scale energy sources, food technology, construction materials). Cooperative programs involving U.S. universities with activities in these areas could be valuable and should be relatively easy to establish if modest funding is available.

The proposed facility near Lagos for maintaining and overhauling jet aircraft, which is to rely heavily at first on the importation of foreign technological skills, could provide an unusual opportunity to couple operational activities with a major program for training large numbers of technicians in various trades in addition to those who are to be employed at the facility. The co-location at the site of a major vocational training facility could help provide the much needed link between schooling and on-the-job training. Also, the facility might provide an opportunity for bilateral cooperation in training areas of particular strength in the United States.

Nigeria has not been successful in attracting Americans to Nigeria as technical advisers and faculty members and has turned to other countries, particularly India and Eastern Europe. The U.S. Government might consider steps to bring together selected U.S. firms with interests in Nigeria with Nigerian officials to explore the feasibility of placement of Nigerian specialists in firms under conditions that will benefit both the firms and the specialists. Also, the government might examine the specific requests for training in management of public sector technologies and determine whether appropriate arrangements can be made with U.S. organizations to respond to such requests.

Most of Nigeria's activities in science and technology could benefit from collaborative arrangements which effectively draw on the experience of U.S. institutions that have successfully addressed similar problems, albeit in a different setting, for many years. However, these U.S. institutions must be carefully selected, on the basis of past performance and of commitment on the part of high quality scientists and engineers. The Nigerian leadership in science and technology, at both the national and the institutional levels, is quite sophisticated and gives great importance to the quality of the participants in technical endeavors. Still, there is a continuing temptation on the part of both the U.S. and Nigerian Governments to draw on those U.S. specialists and institutions which are most readily available with inadequate attention to demonstrated capabilities.

In short, the most critical need is for a funding mechanism which will enable U.S. specialists to make short-term (i.e., 1-2 months) and long-term (i.e., 1-2 years) visits to technical institutions in Nigeria under conditions that will enable them to contribute effectively to the work of these institutions. A second financial need is for partial support of Nigerian specialists who wish to attend conferences in the United States or spend sabbaticals at U.S. universities. Finally, small research grants to Nigerian institutions and similar funds to U.S. universities would enable development of sustained cooperative research programs. Assuming that AID funding will be available in the agriculture field, additional funding of about $500,000 per year for program activities could support a meaningful program in the physical, engineering, and related sciences.

APPENDIX A

INSTITUTIONS

1. University of Ibadan
2. University of Ife
3. University of Nigeria
4. Ahmadu Bello University
5. University of Lagos
6. University of Benin
7. Yaba College of Technology
8. Institute of Management and Technology
9. Federal Institute of Industrial Research
10. Projects Development Institute
11. Road and Building Research Institute
12. Rubber Research Institute of Nigeria
13. Nigeria Institute for Oil Palm Research
14. Leather Research Institute
15. National Institute for Trypanosomiasis Research
16. Institute of Agriculture Research
17. Nigerian National Petroleum Company
18. Nigerian Electric Power Authority
19. Nigerian Standards Organization
20. Ministry of Works, Engineering

1.) University of Ibadan, Ibadan

Established: 1948; degrees certified by University of London until 1962.

Enrollment:

1976/77

Arts and Social Science	2,460
Science	1,417
Education	1,700
Medicine	1,441
Engineering and Technology	296
Agriculture	863
Veterinary Medicine	289
Total	8,466
Sub-degree	684
First degree	7,601
Higher degree	181
Total	8,466

Faculties/Departments:

Faculty of Agriculture & Forestry--Agricultural Biology, Agricultural Economics, Agricultural Extension, Agronomy, Animal Science, Forest Resource Management.
Faculty of Arts--Arabic & Islamic Studies, Classics, English, History, Language Arts, Linguistics & Nigerian Languages, Modern Languages, Philosophy, Religious Studies, Theater Arts.
Faculty of Education--Adult Education, Institute of Education, Library Science, Secondary Education.
Faculty of Medicine--Pre-Clinical Departments: Anatomy, Biochemistry, Physiology. Clinical Departments: Anesthesia, Chemical Pathology, Child Health, Community Health, Food Science & Applied Nutrition, Hematology, Medical Laboratory Technology, Medical Microbiology, Nursing, Obstetrics & Gynecology, Ophthalmology, Oto-Rhino-Laryngology (Ear, Nose, Throat), Pathology, Pediatrics, Pharmacology, Preventive & Social Medicine, Psychiatry, Radiology, Surgery.
Faculty of Science--Archaeology, Botany, Chemistry, Geology, Mathematics, Physics, Statistics, Zoology.
Faculty of Social Science--Economics, Geography, Political Science, Sociology.
Faculty of Technology--Agricultural & Forestry Engineering, Food Technology, Machine Design & Production Engineering, Petroleum Engineering.
Faculty of Veterinary Medicine--Veterinary Anatomy & Physiology, Veterinary Medicine & Surgery, Veterinary Pathology.

Agriculture:

In 1978/79 academic year undergraduate enrollment was about 1,000 students and graduate enrollment was 202 students. Graduate students break down as follows:

Agriculture Biology	48
Agronomy	51
Agriculture Economics	46
Animal Science	27
Forest Resources	26
Agriculture Extension	4
Total	202

Graduate program geared to M.S. program which requires one year of academic work and small research project. Best students proceed to Master of Philosophy which requires additional academic year and thesis. Most senior faculty hold advanced degrees from first class institutions abroad. Largest and most prestigious agriculture faculty in country.

Forestry processing equipment old and deteriorating. Government needs to train technologists for operation of planned pulp mills. Also needs field station for forestry research and training. Some collaboration exists with Institute of Forestry Research due to processing equipment available there. Waiting list exists for forestry graduates (30/year) but they are often placed out of specialty.

Budget cuts have hurt curriculum at time when student body increased in size due to government mandates. Agriculture research and training farm has been reduced in size. Equipment is old and outdated.

Agronomy department working on NSTDA grant with research groups from other universities. Agronomy Department has good equipment donated by Shell and other companies as compensation for consulting work. New arrangement will permit staff to serve as consultants upon approval of department head and dean. Fees earned will be split equally betewen staff member and department.

Engineering and Technology:

Officially became faculty four years ago. Dean estimates fifty percent understaffed due to budget restraints. At least one Canadian on staff. Canadian aid will end soon, further handicapping department. No research labs. Instruction labs very modestly equipped. Crates of equipment not unpacked due to lack of funds needed for installation. Priority of problems listed--staffing, research, equipment, operating funds, no extension service for technology transfer, and shortage of qualified workers.

Academic staff	24
Undergraduates	285
Post graduates	20

2.) University of Ife, Ile-Ife

Established: 1961; originally established near University of Ibadan; moved to present site (50 miles east of Ibadan) in 1967; agriculture research unit remains in Ibadan.

Enrollment:

1976/77

Arts and Social Science	1,519
Science	869
Education	889
Medicine	318
Engineering and Technology	659
Agriculture	376
Pharmacy	386
Administration	399
Law	252
Total	5,667

Sub-degree	171
First degree	5,023
Higher degree	473
Total	5,667

Faculties/Departments:

Administratively, Faculties grouped into two Colleges--Humanities and Science

College of Humanities:

Faculty of Arts--English, Fine Arts, French, German, History, Mathematics, Philosophy and Religious Studies, Yoruba.
Faculty of Law--Law.
Faculty of Education--Adult Education, Secondary Education.
Faculty of Social Science--Anthropology, Economics, Geography, Political Science, Sociology.

College of Science:

Faculty of Agriculture--Agricultural Economics, Animal Science, Extension Education and Rural Sociology, Plant Science, Soil Science.
Faculty of Health Science--Community, Hospital and Nursing Care, Human Behavior and Human Biology, Pathology.
Faculty of Pharmacy--Pharmaceutical Chemistry, Pharmaceutics, Pharmacognosy, Pharmacology, Pharmacy.
Faculty of Science--Biology, Chemistry, Geology, Mathematics, Physics.
Faculty of Technology--Agricultural Engineering, Chemical Engineering, Computer Science, Electronic and Electrical Engineering.

Physics:

Faculty adequately staffed with well educated people. Attempts to develop competence in nuclear research stifled by lack of funds. Necessary equipment waiting for installation or purchase due to shortage of funds. Ambitious, but expensive, program planned directed to nuclear power. Similar program at Ahmadu Bello but even less advanced due to lack of funds.

NSTDA research project for Solid State Devices has good equipment but small scale and no apparent plan to develop and use results of research.

Agriculture:

Space and original equipment adequate. Constraints are maintenance of equipment, lack of parts, and service deficiencies such as gas, water, electricity and communications. Long delays encountered in ordering and importing chemicals and equipment complicate service deficiencies. NSTDA has funded project to convert animal, urban and industrial wastes into fertilizer. Project conducted with Universities of Ibadan and Nssuka but in early stages. Original association with University of Wisconsin which included U.S. faculty at Ife ended several years ago.

3.) University of Nigeria (UNN), Nsukka

Established: 1961; establishment greatly aided by Agency for International Development and particularly long term collaborative programs with Michigan State University; large portion of teaching staff American trained; almost complete destruction during civil war of 1967-69; damages to facilities almost totally repaired.

Enrollment:

Arts and Social Sciences	1,356
Science	1,294
Education	921
Medicine	601
Engineering and Technology	789
Environmental Design	453
Agriculture	520
Administration	406
Law	372
Total	6,712
Sub-degree	382
First degree	6,259
Higher degree	71
Total	6,712

Faculties/Departments:

Faculty of Agricultural Science--Agricutural Management, Animal Science, Crop Science, Food and Home Science, Soil Science, Veterinary Science, Horticulture, Agriculture Extension.
Faculty of Arts--Archaeology, English and Dramatics, Fine and Applied Arts, History, Languages (French, German, Russian, Spanish), Mass Communications, Music, Philosophy and Classics.
Faculty of Business Administration--Business Administration, Estate Mangement, Finance.
Faculty of Education--Health and Physical Education, Institute of Education, Secondary Education, Vocational Teacher Education.
Faculty of Engineering--Agricultural, Civil, Electrical and Electronics, Mechanical, Architecture, Surveying.
Faculty of Law--Commercial and Property Law, International Law and Jurisprudence, Public and Private Law.
Faculty of Medicine--Anatomy, Medicine, Obstetrics and Gynecology, Ophthalmology, Pathology, Pharmacology/Therapeutics, Physiology, Psychiatry, Surgery.
Faculty of Science--Biochemistry, Botany, Chemistry, Geology, Mathematics/Statistics, Microbiology, Pharmacy, Physics, Zoology.
Faculty of Social Science--Economics, Geography, Political Science, Psychology, Religion, Sociology/Anthropology.

Engineering and Technology:

Staff primarily Nigerian with typical loads of three two-hour lectures per week (or equivalent labs). Promotion depends partially on publication. Consulting (with university collecting 50 percent of fees) has been approved in principle. Industry participates by enrolling in extramural courses but lack of funds and poor administration inhibits other contacts. NSTDA has funded three research projects. Engineering program includes courses in

humanities, general studies and management. Required physics and chemistry courses are taught by Faculty of Science.

Civil Engineering conducting research on soils and erosion but without assistance of outside grants. Department needs funds to purchase new undergraduate equipment. Shortage of staff caused by industrial competition. Civil engineers with three to five years experience earn as much as senior professors.

Mechanical Engineering received a large NSTDA grant for energy research (solar, fossil fuel, biomass) and has started to collect data. Current space inadequate and equipment obsolete. Chemical Engineering is a proposed option to Mechanical Engineering.

Electrical Engineering performs research in projections of electricity demand but other research is limited. Equipment breakdowns coupled with poor repair capabilities hinder research attempts.

Agricultural Engineering performs research on machines for production and storage of agriculture products. Also participating in solar energy study.

Agriculture:

Enrollment has increased to 700 students in 1978/79. Students do research projects at Nigerian Institute for Oil Palm Research and Rubber Research Institute of Nigeria. Both institutes send staff to lecture at Nsukka. Program includes one year of farm practice. Most graduates accept government positions. Research mostly interdepartmental. Rural development studies include information gathering on land tenure, socioeconomics, and social attitudes. Soil Science studies include erosion control, soil conservation, and improved agricultural methods.

4.) Ahmadu Bello University (ABU), Samaru

Established: 1962; only university in North until 1975.

Enrollment:

1976/77

Arts and Social Sciences	1,620
Science	281
Education	413
Medicine	1,584
Engineering and Technology	436
Environmental Design	352
Agriculture	231
Veterinary Medicine	220

Administration		692
Law		719
Organized Prelim		831
	TOTAL	7,879

Faculties/Departments:

Faculty of Administration--Accounting, Business Administration.
Faculty of Agriculture--Agricultural Economics and Rural Sociology, Agricultural Engineering, Agronomy, Animal Science, Crop Protection, Extension and Research Liaison Services, Plant Science, Soil Science.
Faculty of Arts and Islamic Studies--Arabic, Education, English, French, Hausa, History, Islamic Studies.
Faculty of Arts and Social Sciences--Economics, English, Fine Arts (Studio Art and Art History), French, Geography, Government, History, Mathematics, Sociology.
Faculty of Eduction--Art Education, Elementary Teacher Training, Library Science, Music Education, Physical and Health Education, Secondary Education.
Faculty of Engineering--Civil, Electrical, Mechanical, Surveying.
Faculty of Environmental Design--Architecture, Building, Planning.
Faculty of Law--Islamic Law (through Institute of Administration), Private Law, Public Law.
Faculty of Medicine--Biochemistry, Medicine, Physiology, Surgery.
Faculty of Science--Biology, Chemistry, Education, Geography, Geology, Industrial Chemistry, Mathematics, Pharmacy, Physics.
Faculty of Veterinary Medicine--Veterinary Medicine.

Engineering and Technology:

Eighty faculty members instruct 520 students. About five percent of student body are graduate students. Faculty number includes ten graduate assistants and ten assistant lecturers (also graduate assistants). Fifteen expatriates on faculty but number decreasing.

Undergraduate program extended from three to four years. Fourth year for practical experience but no funds or definite plans to implement internships. Applications dropping due to decrease in qualified applicants and competition from other professions which are considered more lucrative--business, medicine. Civil engineering expanding. Research modest and centered on local needs. Equipment somewhat out of date. Industry participates in extramural courses.

Agriculture:

About 1,000 students enrolled in a two year program (not included above). Fifty full time faculty includes graduate assistants. Faculty experiences difficulties recruiting first rate staff members. University program recently added fourth year for experience. Associated with NSTDA Institute of Agriculture Research and Agriculture Extension Liaison Service located in Samaru. Research units and agriculture faculty share staff and facilities.

5.) University of Lagos, Lagos

Established: 1962.

Enrollment:

1976/77

Arts and Social Sciences		1,685
Science		543
Education		1,013
Medicine		755
Engineering and Technology		349
Environmental Design		157
Administration		762
Law		416
	TOTAL	5,680
Sub-degree		694
First degree		4,755
Higher degree		231
	TOTAL	5,680

Faculties/Departments:

College of Medicine--Basic Medical Sciences, Clinical Sciences, Dental Sciences.
College of Education--Secondary Education.
Faculty of Arts--African Languages and Literature, English, Geography, History, Linguistics, Modern European Languages (French, German, Russian), Philosophy.
Faculty of Business Administration--Accounting, Actuarial Science and Insurance, Business Administration, Finance.
Faculty of Engineering--Chemical, Civil, Electrical, Mechanical, Surveying.
Faculty of Environmental Design--Architecture, Building Technology and Design, City and Regional Planning, Landscape Arthitecture.

Faculty of Law--Law.
Faculty of Science--Biology (including Marine Biology and Oceanography), Chemistry, Computer Science, Mathematics, Physics.
Faculty of Social Science--Economics, Mass Communications, Political Science, Sociology.

Engineering and Technology:

Faculty well supported financially. Mechanical Engineering is strong with several research grants and good facilities. New laboratories in excellent condition. They are to be used for research and, it is hoped, by local industries.

Chemical Engineering is another strong department with 18 faculty members, mostly trained in U.S. and Canada. Admissions deliberately limited to about 20 per year. Ninety chemical engineers graduate annually in Nigeria. Four universities offering Chemical Engineering collaborate to limit numbers to estimated annual demand by industry and government of about 100. Chemical Engineering laboratory in good condition and includes some fairly sophisticated research instruments such as a mass spectrometer. Premier Chemical Engineering Department in country.

6.) University of Benin, Benin

Established: 1972; founded as Institute of Technology in 1970; name changed to University of Benin in 1972; currently on two separate campuses but moving to a new, permanent site.

Enrollment:

1976/77

Arts and Social Science	424
Science	454
Education	283
Medicine	357
Engineering and Technology	239
Pharmacy	114
TOTAL	1,871

Faculties:

Faculty of Education--Science Education,
Faculty of Engineering--Civil, Electrical and Electronic, Mechanical, Petroleum/Chemical, Production Technology/ Industrial.

Fa lty of Medicine and Pharmacy--Anesthesia, Anatomy, Bio-chemistry, Child Health, Community Health, Medicine, Mental Health, Obstetrics and Gynecology, Ophthalmology, Pathology, Pharmacy and Pharmacology, Physiology, Radiology, Surgery.
Faculty of Science--Biological Sciences, Chemistry, Geology, Mathematics, Physics.

Engineering and Technology:

Adequate staff totaling sixty-two restricted by facilities which suffer from limited space. Mechanical and Chemical Engineering labs have good equipment, but Electrical and Civil Engineering labs have poor equipment. Some equipment remains uncrated. Number of undergraduate degrees awarded (including sub-degrees) in 1979 was very low:

Civil	19
Mechanical	4
Chemical	4
Electrical	6
Petroleum	0
	33

First degree program is now five years with one year in industry. Graduates experience no trouble finding jobs.

Mechanical Engineering Department working on two NSTDA research grants on industrial acoustics. Grants obtained through senior staff initiative.

Science:

Physics department claims to have best optometry school in Africa with great demand for garduates. Optometry department will soon separate from physics. Chemistry laboratory is old fashioned.

7.) Yaba College of Technology, Lagos

Yaba is the oldest higher education institute in Nigeria. It was restructured as a polytechnic after the University of Ibadan was established in 1948. Enrollment is 2000 full time and 1000 part time students. Yaba offers the newly initiated Nigerian National Diploma (NND) for four years of study (three years attending school and one year industrial experience). Part time students require five years of evening classes. Graduates are reported to be in great demand by private industry.

The faculties include:

Art and Design
- Ceramics
- Fine Arts
- Printing
- Textiles

Engineering
- Electrical
- Mechanical
- Civil

Science and Math

Management and Business

The physical facilities are in poor condition.

8.) Institute of Management and Technology, Enugu

This Polytechnic is designed to train secondary school graduates in two years to a "Technical Associate" degree and, in two years more, to a higher technical degree. The purpose is to prepare "technologists," specialists below the level of engineer but more qualified than technicians. Because the pay for a technologist is lower than an engineer's pay, the brightest graduates want university degrees and often continue studies at a university. (At the University of Lagos, for example, some 20 percent of entering engineering classes are former polytechnic students.) The Rector would like to have government permission to offer university level training. It is a vigorous institution, rapidly growing, with many applicants (2000 students in both engineering and accounting).

The Chemical Engineering Laboratory has glass equipment which is largely broken. Replacement pieces are almost impossible to obtain. Substitute metal parts are hard to fabricate with the limited facilities available. The mechanical workshop is adequately equipped to train students in simple machining, welding, etc. The electrical testing laboratory has equipment for motor tests. The Institute does not have a steam generator so it must rely on an unreliable electricity source. The computer does not operate due to lack of funds. Links with industry are limited to student apprenticeships.

9.) Federal Institute of Industrial Research (FIIRO), Lagos

This well-established institute began in 1955 and has modest facilities and a library. Its work is similar to that of the Projects Development Institute, Enugu, in the development of raw materials used in local industries; e.g., brick manufacture from local clays. Most of the research effort is on food materials--beer; gari; palm wine (distillation and preservation); coil fiber; protein-fortified maize beverage to supplement native diet; and fish drying. Also some work has been performed on skin cream and flamboyant tree wood for paper making.

The staff includes 100 scientists and senior technical staff and 250 junior and support staff. It provides limited technical services to industry, state, and federal governments. It conducts quality control for the Nigerian Standards Organization and (for nominal fees) for private industry. Its industrial analysis division does market research, apparently after the new products have been developed in the laboratory. The food and petroleum industries recruit away chemical engineers.

Projects are sometimes multidisciplinary team efforts. A refractory brick study, for example, included a physicist, a ceramist, an engineer, and a marketing specialist. The biggest success has been directed to gari (a staple from cassava) which is now produced on a semi-commercial basis. New products are developed, and then a manufacturer is sought for them. However, the Institute has not been successful in commercialization of most of its research results.

The governing board of FIIRO includes a representative connected with industry--from the Nigerian Chamber of Commerce or the Nigerian Association of Manufacturers. The budget for 1979 was exceeded in six months; and the 1980 budget is expected to decrease.

10.) Projects Development Institute, Enugu

The Institute was formerly the Projects Development Agency (PRODA) established in 1970 by East Central State (now Anambra and Imo States) to help restart the cement, steel, gas and general industry after the civil war. It was absorbed by NSTDA in 1976 and now conducts both research and production activities. The Institute makes bricks, egg cartons (from rice straw and waste paper), and glass laboratory equipment. It has developed a "tearless gari machine" (smokeless frying pan), aluminum harvesting sickles for oil palms, and bricks from local clays. The Institute believes that local industry does not look far enough into the future and therefore industry does not invest

in research and development. The Institute attempts to mitigate this trait through developing products tailored to local production ability.

Plans have been approved for a first phase expansion costing $4.8 million which includes an engineering workshop, staff quarters and a multi-story research building. Funding comes from NSTDA allocations; sale of cassava; sale of egg cartons and bricks; and consulting fees for geological surveys on clay used in brick, sanitary ware and pottery manufacture (consulting fees are the best source of income).

The staff, totaling 348 with 22 scientists, includes geologists, mechanical engineers, chemical engineers, chemists, physicists, and ceramists. It is stable except for junior positions. Technicians often go to university after a year's lab experience. Industry attracts some scientists away since it pays roughly twice as much. Many inquiries have been received concerning available positions from Nigerians and expatriates. Activity is limited by space, staff, and budget. The cost of the research staff is about three times their nominal salaries. The Institute provides housing, car loans, and free medical treatment. The staff lectures at UNN, and professors from UNN lecture at the Institute. Engineering students work summers at the Institute.

11.) Road and Building Research Institute, Lagos

The Institute, currently housed at the New Secretariet in Lagos, has a staff of two with plans to increase its size to twelve scientists within five years. Staff recruitment, except for senior positions, is anticipated to be difficult. The research direction will emphasize buildings over roads, with materials testing remaining a function of the Ministry of Works.

The new research lab in Lagos will be completed in 1979. Present expansion plans call for a larger facility in Ikeja (land has not yet been acquired) and several regional facilities.

12.) Rubber Research Institute of Nigeria (RRIN), Iyanomo

This newly revitalized institute is operating under great difficulties, especially in attracting staff. Housing at the institute is not yet available, and some staff members are living in primitive conditions in Benin. Electricity supply at the Institute is erratic.

As evidenced by displays and talks at "Rubber Day" (March, 1979), some good studies are in progress on soil types, tapping methods, and plant diseases. The rubber industry is in bad

condition with many old rubber trees abandoned and not producing. There is little monetary incentive to make rubber production attractive to individual farmers. The civil war virtually stopped rubber production.

The Institute dispenses advice, sells tapping knives, collection cups, etc. at very low (subsidized) prices and is trying to persuade farmers to collect rubber once again. A large government allocation to stimulate rubber production was announced but optimism remains guarded.

13.)
Nigerian Institute for Oil Palm Research (NIFOR), Near Benin City

NIFOR was founded as the Oil Palm Research Station by the British in the 1930s, and was taken over by the Nigerians in 1963. NIFOR is the leading oil palm research institute in the world, with 40 years experience in research and application and many significant developments. Application of research results in Nigeria has been severely constrained. NIFOR's extension service has limited funding and personnel, and must work through the inadequate state extension services. To reverse the decline in oil production, large plantations and a much more effective extension service appear to be essential.

NIFOR is a self-sufficient community of 4,000 people living on about 1900 hectares near Benin City. 1000 hectares are devoted to palm plantations producing salable products. In addition, it has several research stations around Nigeria. Most of the scientific staff is Nigerian. Facilities and research techniques are well establisned, with up-to-date equipment, a small library, and an IBM/3 computer system. NIFOR runs training programs for Nigerians and others; has some university doctoral candidates who do their research there; and sends staff overseas for training (e.g., to Wales, and to Wisconsin).

Research has concentrated on oil palm seed germination, hybridization, crop husbandry and protection, harvesting methods, and oil processing. NIFOR now studies coconut palms, raphia palms, date and ornamental palms. Research achievements include the development of short-stemmed, early-bearing oil palms; rapid germination techniques; and commercialization of palm wine (from sap of the raphia palm). Studies of vegetative reproduction are being initiated.

The old, dangerous, inefficient oil-processing plant is on its last legs. A new Dutch (Stork) plant is to be commissioned in 1979. Products are palm oil and palm kernels; the "light shells" are burned for power generation. Effluent is a problem, but might be used as plant nutrient.

14.) Leather Research Institute, Samaru

The Institute was formerly a training center offering certificates in leather crafts and processing. Construction is underway to expand teaching and research facilities. Therefore, no research is currently underway. The old facilities are very modest. Staff and funding appear to be a major problem.

15.) National Institute for Trypanosomiasis Research, Kaduna

The main research is directed to sterile fly techniques for control of the tse-tse fly which spreads trypanosomiasis (sleeping sickness). The staff includes 15 professional positions at two stations (Jos and Kaduna). Seven staff members are abroad for advanced training.

A major constraint is power failures which will soon be remedied by the recent purchase of a generator for the institute. Research depends on adequate supply of tse-tse flies, which must be bred under fine temperature and humidity limits. Thus, a power failure destroys months of work.

16.) Institute of Agriculture Research, Samaru

The Institute was established by the United Kingdom to serve West Africa. Now only a few expatriates remain. Research is concentrated on agriculture in the northern states where limited rainfall presents special problems in soil management and crop and livestock production. Strong departments exist in Agronomy, Soil Science, Agricultural Economics, Plant Science, Crop Protection, Animal Production, and Veterinary Medicine. Strong ties are maintained with Ahmadu Bello University and the Agriculture Extension and Research Liaison Service in Zaria. All three work together by sharing facilities and experience. The Institute is included in the National Accelerated Food Production Project administered by the IITA.

17.) Nigerian National Petroleum Company (NNPC), Lagos

The NNPC Research Section, which does not yet perform research, consists of an M.S. polymer scientist, a chemical engineer, a patroleum engineer, and a geologist. The chief function of the Section at present is to train technicians at Calabar in elementary chemistry and geology. Instruction is given by Calabar University lecturers, under contract, with NNPC

specialists visiting every other week to lecture and to see that training emphasizes practical applications over theory. A control lab is being set up at the Port Harcourt Refinery and should be operational in 1979. A research lab is planned for Warri within five years. However, no labs are operating now, and there is no interaction between NNPC and the universities in the area of research.

The Geological Section has 20 geologists and 20 geophysicists. Turnover is a problem. Employees can earn more in private industry but feel more secure, with more job satisfaction in NNPC. NNPC performs some offshore exploration, but contracts for drilling facilities. On shore it determines likely areas, develops international bids, and supervises the work. NNPC does some of its own seismic studies, but oil production is done almost entirely by contractor companies.

NNPC plans to hire graduates from the Petroleum Training Institute at Warri. NNPC employs 300 university graduates (250 technical), mostly trained abroad and mostly working in Lagos. Sixty-nine expatriates are employed for technical backup but NNPC hopes to replace most of them with Nigerians within two to three years.

18.) Nigeria Electric Power Authority (NEPA), Lagos

NEPA hires about fifty university and polytechnic graduates yearly and has established different career paths and training programs for each. Polytechnic positions have an operations orientation. Both training programs concentrate in practical experience. The training program for university graduates lasts two years but suffers from severe attrition even prior to the end of training. The private sector pay differential becomes large once engineers acquire some training or experience in addition to university study.

Instructors are in short supply--the director of training is a Canadian under contract. Some university professors teach training programs and continuing education courses for NEPA staff are held at Ahmadu Bello University. NEPA staff visit universities to give advice on curriculums and to give occasional lectures.

NEPA conducts no independent research. Partially as a result of high attrition, NEPA must resort to expatriate firms for construction and major maintenance projects.

19.) Nigerian Standards Organization, Lagos

The Organization sets standards for consumer products manufactured in Nigeria (examples--betteries, soap) and tests samples taken from production for compliance to standards. Most specifications are adopted with little modification from the United Kingdom. Standard testing for imported products are performed by a Swiss firm under contract. The Nigeria food and drug organization performs a similar function for food and drugs. The organization also assumed responsibilities for introducing the metric system into Nigeria.

Laboratories are located near the Lagos airport, on Victoria Island, and in Enugu. Facilities of the University of Lagos and the Federal Institute for Industrial Research are used. The Victoria Island laboratory is unimpressive. The technical staff of the Organization, including Youth Corps workers, totals sixty people.

20.) Ministry of Works, Engineering Department, Lagos

This department has responsibility for quality control, principally for highway construction. Some materials research is conducted on a limited scale in connection with construction projects in different types of soil conditions. Results of this research are reported at an annual conference which brings together representatives of Government, universities, and the private sector.

APPENDIX B

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